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ABSTRACT

In February of 1990, the Michigan Department of Natural Resources identified 2,662 sites of soil and groundwater contamination in the state of Michigan alone. Half of all United States residents and one quarter of the Canadian population used ground water as their primary source of drinking water. Groundwater and surface water are integrally connected. Groundwater and surface water flow between political boundaries, connecting neighboring states, provinces, and communities. This curriculum was created to better teach concepts related to water, ground water, and pollution prevention to students in grades K-6. It contains 28 activities centering on ground water and related topics, such as the water cycle, recycling and solid waste, hazardous waste, water conservation, ground water protection, and responsible citizenship. The activities are divided into eight sections: (1) Why Is the Earth Called the Water Planet?; (2) How Is Water Stored and Moved on Planet Earth? (3) Where Is Water Found Underground? (4) How Does Water Move Underground? (5) What Natural Factors Influence Water Quality? (6) How Do People Affect Groundwater? (7) How Does the Quality of Groundwater Affect Life on Earth? and (8) How Can We Protect the Quantity and Quality of Groundwater? All activities use a multi-disciplinary, hands-on, participatory approach and include science, art, math, lab, language arts, geography, music, and social studies activities. The activities are indexed by subject area, type of activity (sucy as lab or demonstration), and grade level. Contains a glossary, a list of Michigan Soil Conservation offices, and 25 references. (MKR)

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GEE-WOW!

ADVENTURES IN WATER EDUCATION

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AN EXCITING K-6 CURRICULUM ABOUT WATER AND GROUNDWATER!

INCLUDES SCIENCE, ART, MATH, LAB, LANGUAGE ARTS, GEOGRAPHY, MUSIC, AND SOCIAL STUDIES ACTIVITIES!

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GEE-WOW!
ADVENTURES IN WATER EDUCATION

Editor: Tara Ward
Assistant Editors: Ruth Kraut and Andrea Shotkin

Printed on Recycled Paper

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GROUNDWATER
EDUCATION
MICHIGAN

Dear Educator,

In February of 1990, the Michigan Department of Natural Resources identified 2,662 sites of soil and groundwater contamination in the state of Michigan alone. While this fact clearly concerns those 50% of Michigan residents whose source of drinking water is groundwater, it should concern us all. Half of all U.S. residents and one quarter of the Canadian population use groundwater as their primary source of drinking water. Groundwater and surface water are integrally connected. Many bodies of surface water are recharged at least partially with groundwater. Groundwater and surface water flow between political boundaries, connecting neighboring states, provinces, and communities.

This curriculum has been created in order to better teach concepts related to water, groundwater, and pollution prevention. In it, you will find 28 activities centering on groundwater and related topics, such as the water cycle, recycling and solid waste, hazardous waste, water conservation, groundwater protection, and responsible citizenship.

Activities were developed by educators for classroom-sized groups, and were tested in the classroom. However, they are suitable for smaller youth groups as well. Materials needed are easy to find and inexpensive. All activities use a hands-on and participatory approach in order to fully engage students and to create a memorable learning experience.

The activities are divided into eight sections. To teach a unit on groundwater, educators are encouraged to choose one lesson from each of the eight sections and to teach them sequentially. However, each lesson can also stand alone. More in-depth coverage of a single water-related topic can be accomplished by teaching every lesson in the section of interest. In addition, the activities are indexed by subject area, type of activity (such as lab or demonstration), and grade level. A glossary is at the back of the curriculum.

Most of all, feel free to make adaptations and changes, to infuse it into other subject areas, and to make it your own.

The future quality of our groundwater and environment is dependent on a well-informed and caring citizenry. It is our hope that this curriculum will give youth some tools with which to protect and improve the environment that sustains the plants, animals, and people of our earth.

Yours,

Tara Ward
Editor

Editor: **Tara Ward**
Assistant Editors: **Ruth Kraut, Andrea Shotkin**
Research Assistants: **Scott Miatech, Diane Reed**
Artwork: **Deborah Wentworth**
Computer Layout: **Alissa Leonard**

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Dr. P. J. Puntenney, Executive Director, Environmental and Human Systems Management
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SECTION 1

WHY IS THE EARTH CALLED THE WATER PLANET?

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Water, Water Everywhere:
How is water distributed on Earth?

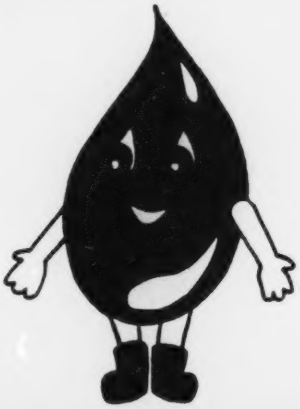
SUMMARY: The Earth is called "the water planet." But how much of the water on our blue planet is available for drinking? This demonstration shows amounts representative of different types of water, and why groundwater is important to life on Earth. The teacher divides up water in front of the class, describing her or his actions step by step to the students.

OBJECTIVE: To demonstrate how limited the usable amount of water on earth is, and why we need to conserve water. To describe how much of the world's water is underground.

VOCABULARY WORDS: salt water, surface water, groundwater, fresh water, polar ice caps

TIME REQUIRED: 5 minutes

MATERIALS NEEDED:
10 Cups of water
Salt
Measuring cup
Stirring spoon or stick
3 Clear jars or containers (1 containing rocks, 2 able to hold 10 cups of water)
Earth poster or globe
2 Spoons
1 Tablespoon measure
Eyedropper



PROCEDURE:

1. Display an Earth poster and/or a globe. Point out the white ice caps and clouds and blue water.

2. Begin with 10 cups of water in one clear container. Ask students how much of this they think represents fresh water, and how much represents salt water. Have a student come up and show his or her guess by dipping out what they think is the correct proportional amount of fresh water from the big container.

3. Set aside 1/3 cup of the fresh water. This represents all fresh water in the world. Have a student taste this water and tell the class whether it tastes drinkable. Explain that only fresh water is drinkable.

4. Mix salt into the remaining 9 2/3 cups of water. This represents all salt water in the world. Have a student taste the salt water and tell whether it is drinkable. Explain that salt water is not drinkable, and that drinking large amounts of it will make a person (and most animals that do not live in the sea) sick. Although humans and most non-sea creatures need fresh water to live, there are many creatures that depend on the oceans and on salt marshes. Have your class name some of these. (*Ocean fish, seals, jellyfish, whales, etc.*)

5. Explain that when water gets very cold, it turns into ice. In some very cold places of the world, nearly all the water has turned into ice. Ask students how much of the world's fresh water occurs as ice. Take 6 tablespoons from the 1/3 cup of fresh water and pour them into an ice cube tray. This represents the 2/3 of the world's fresh water that is tied up in polar ice caps.

6. Pour all but a teaspoon of the remaining fresh water into a clear jar containing rocks. The water in the jar represents the amount of fresh water that occurs in the ground, as groundwater. Groundwater is the source of drinking water for about half of the people in the United States.

7. Show the remaining teaspoonful of fresh water to the class. This represents the total amount of fresh surface water in the world (this includes fresh water lakes, ponds, rivers, and streams). Surface water is the source of drinking water for about half of the people in the United States.

8. With the eyedropper, take three drops of the small remaining amount of fresh water, and show the class that this amount of fresh water represents the Great Lakes. Name the Great Lakes (*Superior, Michigan, Huron, Erie, and Ontario*), and find them and Michigan on a map. Hold the eyedropper high above a metal jar lid or garbage can. Ask students to be very quiet and listen, as the drops representing the fresh water in the Great Lakes fall and make tiny "ping" sounds as they hit the metal.

9. Clouds are made of water. Water vapor holds an even tinier amount of the world's water.

10. Discussion Questions:

a) How much salt water versus fresh water is there in the world? (*There is quite a lot more salt water than fresh water. There is a*

29:1 salty to fresh water ratio.)

b) What is water needed for? *(Plants, animals, fish and people all need water. There are many uses for water.)*

c) Why is fresh water so important? *(It is the only kind of water that people and many animals can drink without getting sick.)*

d) Where can fresh water be found? *(In lakes, including the Great Lakes, ponds, rivers, streams, and underground, as groundwater.)*

e) What would happen if people could not drink the fresh water underground anymore? *(They would all have to depend on the tiny amount of fresh surface water available.)*

f) How should we treat the fresh water underground? *(We should be careful not to waste it, and we should try to keep it clean.)*

EXTENSIONS:

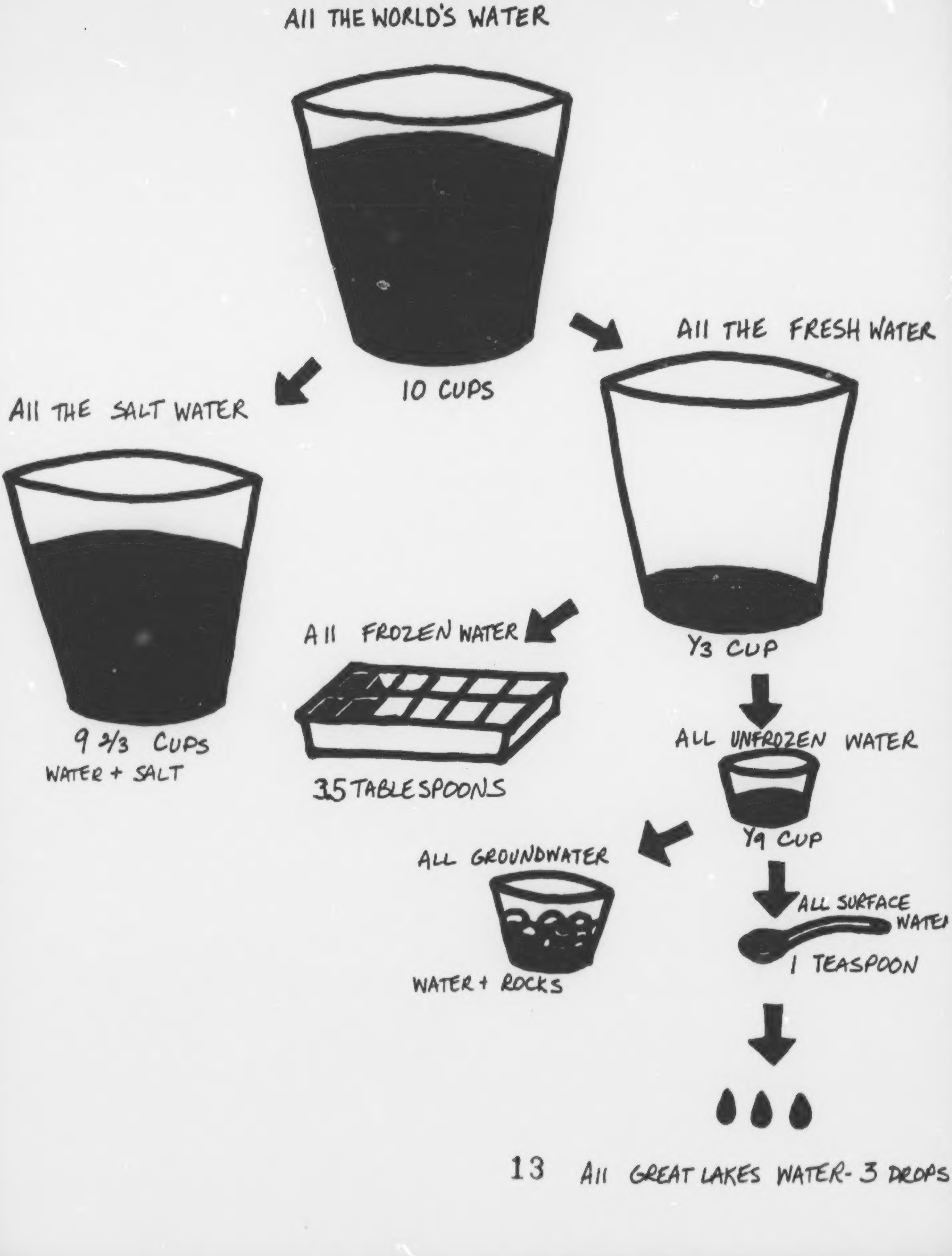
1. Help the class design a bar graph to visually compare the amounts of each kind of water discussed above. The bar graph could be put up on a bulletin board.

2. Divide the class up in order to make a human representation of the comparative amounts of salt water versus fresh water on Earth.

BACKGROUND:

The earth is called the water planet because water, in its liquid form, covers more than 70% of the earth. But most of the water on earth is not the fresh water that we can drink or irrigate with; over 97% of the earth's water is salt water in the oceans. That leaves less than 3% as freshwater. Two thirds of that amount is locked up in glaciers and polar icecaps around the polar regions. Half of what remains after that lies far underground and is too deep to be available for human use.

Of all the water present on the earth, less than 1% is available for our use. This water is found in surface and subsurface locations in the following relative amounts. Surface Water: lakes 2.82%; streams 0.02%. Subsurface Water: soil moisture 0.16%; groundwater 97%.


All THE WORLD'S WATER
10 CUPS
All THE SALT WATER
9 2/3 CUPS
WATER + SALT
All THE FRESH WATER
1/3 CUP
All FROZEN WATER
3.5 TABLESPOONS
ALL UNFROZEN WATER
1/9 CUP
ALL GROUNDWATER
WATER + ROCKS
ALL SURFACE WATE
1 TEASPOON
All GREAT LAKES WATER- 3 DROPS

Water's Ways:

The water cycle's true story

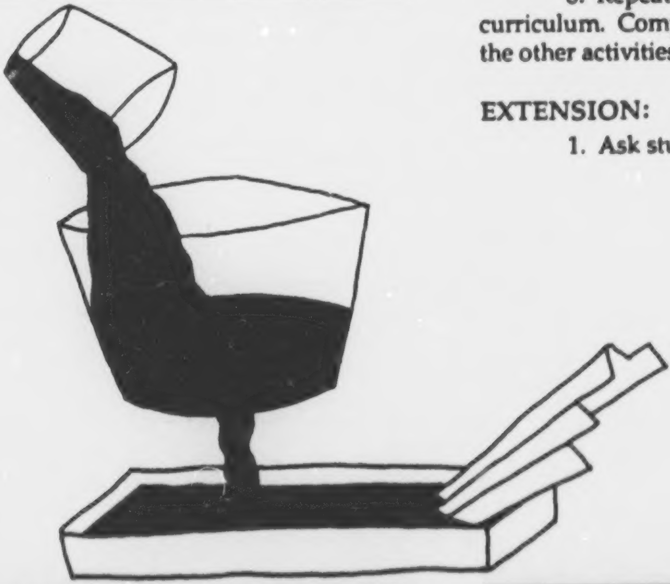
SUMMARY: A system of everyday objects through which water can flow is set up. Students predict and observe how water flows through this system.

OBJECTIVES: To stimulate students' thoughts on the water cycle, and to evaluate their understanding of groundwater in the hydrologic cycle.

TIME REQUIRED: 20 minutes

MATERIALS NEEDED:

Art or writing materials
1 Cup without holes in bottom
The following are the types of materials that may be used to build your water "system" in Procedures 1-3. These are merely suggestions; you may add other materials as well:
Cups with holes in bottom
Funnel
Cloth dish towel
Pitcher to pour water
Flower pot(s)



PROCEDURE:

1. Set up a series of containers (for instance, a cup, a cup with holes, funnel, cloth dish towel) that water can run through (see diagram). Ask the students what they believe will happen when water is poured through the system.
2. Pour water through the system, while students observe.
3. Ask students what happened.
4. Have students sit in a circle.
5. Begin a story about a raindrop, or weather changes, or something related to water. You could start with, "Once upon a time, there was a little raindrop up in a cloud. The cloud began to get full of raindrops, and our raindrop found itself falling and falling down through the sky..." At this point, pass a cup of water to the student next to you. This student tells the next part of the story of the travels of the raindrop, and passes the cup on to the next student. As each student receives the cup of water, it is his or her turn to give the next part of the story.
6. As students tell the story, write down the misconceptions that they mention about the water cycle and about groundwater. Do not point them out as misconceptions to the students at this time. Some common misconceptions are that underground rivers or lakes are common; that clouds are solid objects; that the water cycle is one way—water falls from the sky and is used up; that the core of the earth is made of water; that snow, ice and clouds are a substance other than water; that there is no water in the ground or air; that the source of water is the tap; that ocean water and drinking water are two completely different substances; etc.
7. Have students draw the sequence of the story, or write down parts of the story.
8. Repeat steps 4-6 after doing other activities in this curriculum. Compare your list of misconceptions before and after the other activities, as an evaluatory measure.

EXTENSION:

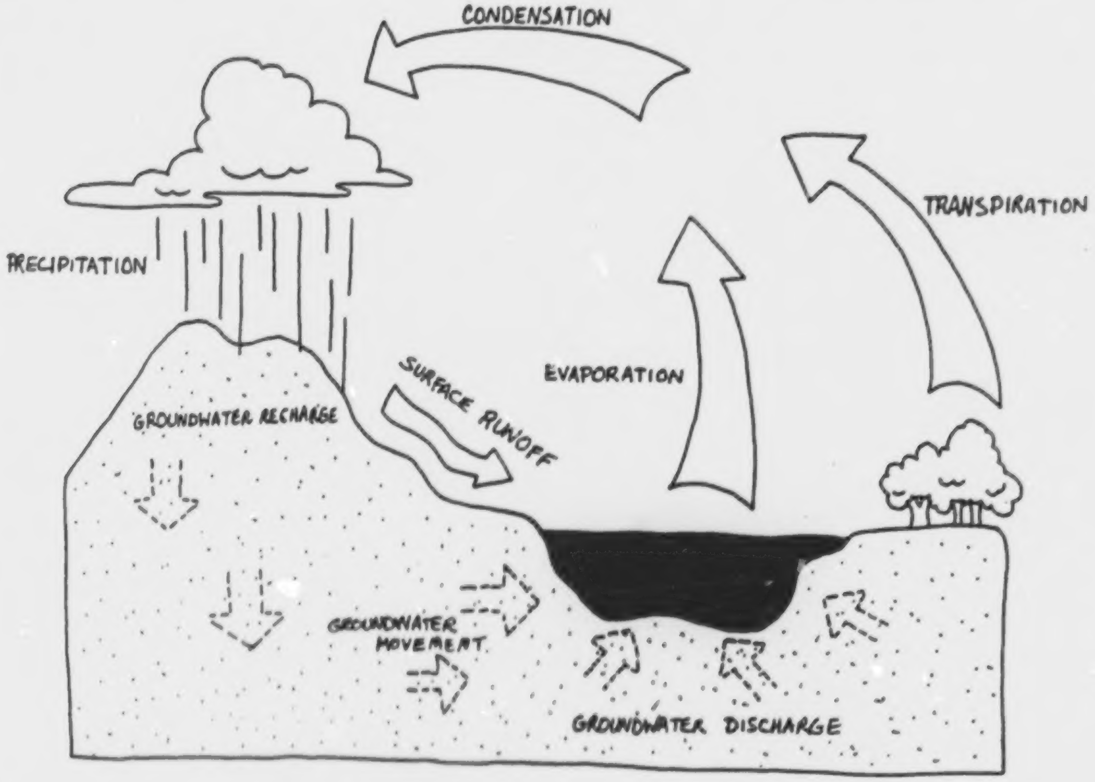
1. Ask students to share their drawings with the class.

BACKGROUND:

Most people, when imagining the movement of water on the earth, think of water as moving downward. This is true in many cases: precipitation falls from the sky, water seeps into the ground, and rivers run downhill. At the same time, there are instances where water does not flow downward.

Groundwater flow is subject to many factors: the porosity and permeability of materials it is flowing through; the location of the water table; discharge of groundwater to the surface; and recharge of groundwater by surface water seeping into the ground.

By viewing water travelling through some common materials and containers, we can begin to get a feeling for water's movement both above and below the earth.


CONDENSATION
TRANSPIRATION
PRECIPITATION
EVAPORATION
SURFACE RUNOFF
GROUNDWATER RECHARGE
GROUNDWATER MOVEMENT
GROUNDWATER DISCHARGE

I Could Write a Book:

The water cycle involves ups and downs

SUMMARY: By drawing and discussing the concepts of up and down as they relate to water, students realize that water occurs in different places, situations, and configurations. Two books, to be kept in the classroom, are the final products.

OBJECTIVE: To relate the concepts of up and down to water.

VOCABULARY WORDS: waterfall, wave, well, spring, evaporation, groundwater, gravity

TIME REQUIRED: 30 minutes

MATERIALS NEEDED:

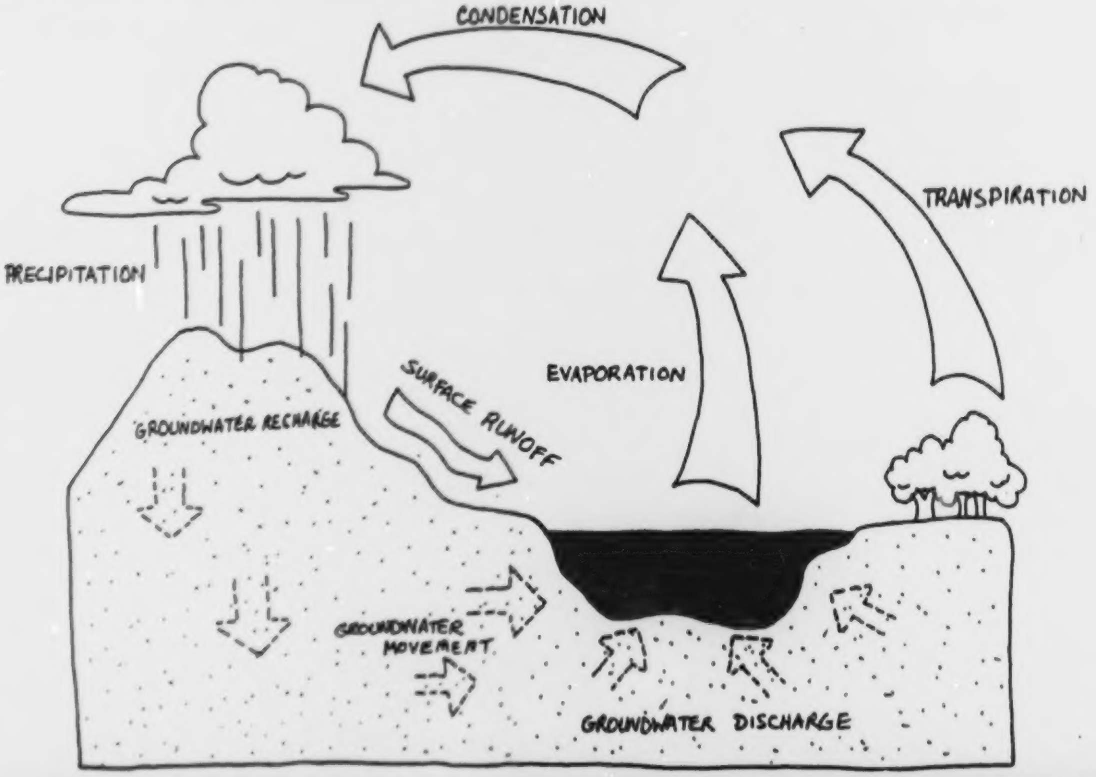
Drawing materials
Stapler

PROCEDURE:

1. Discuss the words "up" and "down."
2. Have each student draw a picture of something going up, or of something going down.
3. Alternate the up and down pictures, and staple them together to make one book.
4. Discuss when water goes down (i.e. rain, snow, waterfalls, water seeping into the ground to become groundwater, etc.) and when water goes up (i.e., wells, drinking fountains, springs, waves, evaporation, etc.)
5. Have each student draw a picture of water going up, or water going down.
6. Alternating the up and down pictures, staple them into another book.

EXTENSION:

1. Ask for 3-4 students to come to the front of the class and imitate some water going up or down. Other students should try to guess what they are acting out.


CONDENSATION
TRANSPIRATION
PRECIPITATION
EVAPORATION
SURFACE RUNOFF
GROUNDWATER RECHARGE
GROUNDWATER MOVEMENT
GROUNDWATER DISCHARGE

BACKGROUND:

The processes that make up the water cycle are all constantly underway so there is no real starting point. You could begin by describing any of the processes, and it might even be helpful to start with a different process each time so that you do not start thinking of one process as the "beginning."

Water goes "up" as it makes its way into the atmosphere through the processes of evaporation and transpiration. Evaporation is the process by which liquid water is turned into water vapor by heat from the sun. The liquid water may be in the form of surface water, such as oceans, lakes, or streams; it may be in the form of precipitation that is falling down through the atmosphere; or it may be in the form of soil moisture. Each year over 100,000,000 cubic miles (about half a billion cubic kilometers) of water are evaporated from the oceans. Transpiration is the process by which plants give off water vapor during photosynthesis. The total amount of water in the atmosphere at any given instant is estimated to be about 3,100 cubic miles. When water vapor in the atmosphere is cooled, it condenses and may fall down as some form of precipitation. Whether the precipitation is in the form of rain, snow, sleet, or hail depends mainly on how cold the air near the surface is. The contiguous U.S. receives about 1,430 cubic miles of precipitation per year.

The water in run-off generally makes its way to the lowest place it can get to due to the force of gravity. This process creates water going "down" in instances such as waterfalls. An estimated 9,000 cubic miles of water are returned to the oceans each year by streams and rivers; run-off and groundwater are both contributors to this amount.

Finally, there is the water that moves down into the earth through infiltration. This underground water, like run-off, is also forced by gravity to move from higher elevation to lower elevation. However, the underground movement of water is generally much slower: it ranges from several feet per day to a few inches per century.

SECTION 2

HOW IS WATER STORED AND MOVED ON PLANET EARTH?

I'm a Raindrop:

The water cycle through visual imagery

SUMMARY: Through a song, visual imagery, and dramatic presentation, students learn about the water cycle.

OBJECTIVE: To follow the journey of a raindrop through the water cycle.

VOCABULARY WORDS:
groundwater, well, spout, sewer

TIME REQUIRED: 20-30 minutes

MATERIALS NEEDED:
Blue paper
Scissors
Drawing materials
String
Hole punch
Lined writing paper and paste (optional)
A large piece of paper, with a large raindrop outlined on it (optional)

PROCEDURE:

1. Sing the song, "The Itsy Bitsy Spider." Teach the children the motions that go along with it.

The itsy, bitsy spider went up the garden spout.
(Index fingers matched up to thumbs, walk upward)
Down came the rain and washed the spider out.
(Wiggle fingers as arms are brought down)
Out came the sun and dried up all the rain,
(Circle made with both hands up high for the sun)
And the itsy, bitsy spider went up the spout again.
(Repeat spider motion from first line)

2. Use the following script or create a similar simple story outline that allows your students to fill in the details. "...." indicates a pause for students to form their mental pictures.

"In a few moments, I am going to tell you an adventure story. I will tell a very simple story and you will get to fill in (or imagine) the rest in your mind. I will ask you to pretend you are a raindrop, and imagine all the things that I say.

Another option is to tell students that they are a tiny video camera inside a raindrop falling from the sky, and ask them to imagine their own raindrop story.)

"Now lay your heads down on your desks. Close your eyes and try to imagine the things that I say.

"Pretend, in your mind, that you are a raindrop .... You are way up high in the clouds. Imagine the clouds around you .... Now you are getting bigger, and you begin to fall toward the earth .... When you reach the earth, you land somewhere, on something. Imagine what you landed on ....

"Now you slide or trickle down to the soil. Imagine what the soil is like .... You begin to move down into the soil, going deeper and deeper into the ground. Imagine what you see along the way .... For a long time, you keep moving down.

"You find that there are many other raindrops down underground, moving through the earth. Now, you are all moving sideways instead of down. Imagine what the earth is like with the raindrops moving through it sideways ....

"After a long time, you begin to move more quickly. Then, suddenly, you move upward very quickly. You come out of the ground and end up .... somewhere. Imagine where you are now ....

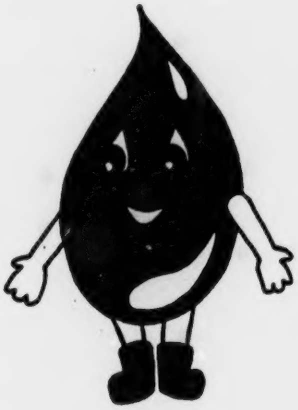
[Optional: "The sun is shining. You are getting warmer, in fact, so warm that you are coming apart. All your little tiny pieces float up into the air .... They go higher and higher, blown by the wind. Finally they reach the clouds and become a raindrop again.]

"Remember your adventure from cloud to earth, down underground, back to the top of the earth [and back to the clouds] .... Remember as much as you can about your adventure .... (long pause)

.... Then, open your eyes and sit up."

3. Have students share with the class what they saw underground; where they landed on the ground when falling from the cloud; and where they came out of the ground.

4. Have each child cut blue paper in the shape of a raindrop. On the raindrop he or she should draw one episode of his or her raindrop story. Older students can write short descriptions of their drawings on the back of the raindrop, after gluing lined writing paper to it. Punch a hole in the top of the raindrop and run a string through it. Hang raindrops from the ceiling or on a big raindrop outline on the wall or chalkboard.



EXTENSIONS:

1. Divide the class into groups of 3 or 4. Let each child tell his or her own raindrop story to the small group (either one they create at the time, or the one that they imagined during the imagery session).

2. Have the group make up motions to go with their raindrop stories.

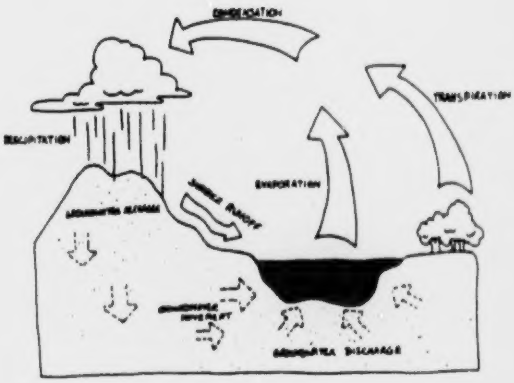
3. Ask one or two students to act out their raindrop stories, with motions, for the class.

4. Read The Magic Schoolbus at the Waterworks, by Joanna Cole, to the class. Published in 1986 by Scholastic, Inc., New York, ISBN 0590403613, it is currently (1990) available in hardcover or paperback.

BACKGROUND:

Understanding the hydrologic (water) cycle is a fundamental element to understanding groundwater. That is because groundwater is often a neglected component of the hydrologic cycle. We tend to omit that which we cannot readily see or understand, and groundwater falls into this category. There is much more involved in the water cycle than simply rain (downward) and evaporation (upward).

There are also many misconceptions about groundwater, such as the erroneous belief that water moves underground in the the form of rivers. Water actually moves very slowly underground, through pores in the soil, and its movement is measured in inches per day (inches/day) or feet per year (feet/year). However, when the concept of "water underground" is added to our awareness of how water, in its various forms, moves and is stored on Earth, the whol cycle begins to make much more sense. In fact, it seems astounding that we ever thought we understood the water cycle before we understood groundwater!



Looking Closely at Clouds:

Creating clouds as art

Adapted with permission from *Science Curriculum Support Guide, Michigan Department of Education, Lansing, MI*

SUMMARY: Students discuss clouds, observe a demonstration, then draw, paint, and/or construct some cloud artwork.

OBJECTIVES: To learn some properties of clouds and to recognize their differences through art projects and a simple demonstration.

VOCABULARY WORDS: cloud, rain, sleet, hail, snow

TIME REQUIRED: 45 minutes

MATERIALS NEEDED:

4 Magazine pictures of clouds
4 Very large pieces of white paper
Paste
Drawing materials
Bucket or bowl
Sponge
Water
Blue construction paper (optional)
Fingerpaint ingredients (optional): 1/2 cup soap flakes, 2 Tbs. liquid laundry starch, water
Tag board (optional)
2 Bags of cotton balls (optional)

PROCEDURE:

1. Discussion Questions:

a) Do clouds always look alike? *(No)*

b) What color are clouds? *(They appear to be many colors at sunrise and sunset, but most often are white or gray.)*

c) Are some clouds higher in the sky than other clouds? *(Yes)*

d) Can clouds ever be touched? *(Yes, fog can be touched.)*

e) On a cloudy day, where is the sun? *(Behind clouds)*

f) Can an airplane fly above the clouds? *(Yes)*

g) Does a cloud stay still or does it move? How can you tell? *(Clouds move. By sitting or lying in one place and staring at clouds you can see them move. You can also see them change shape.)*

h) What are clouds made up of? *(Water droplets and ice particles.)*

2. Tell students that clouds gather water and at a certain time (saturation) clouds drop water. What can come from clouds? *(Rain, snow, sleet, and hail)*

3. Ask two students to stand side by side with a bucket or bowl in between them. The students should hold a sponge over the bucket or bowl.

4. Explain that the sponge represents a cloud. Slowly pour water onto the sponge. As the "cloud" becomes saturated, water will drip into the bucket or bowl. This represents precipitation.

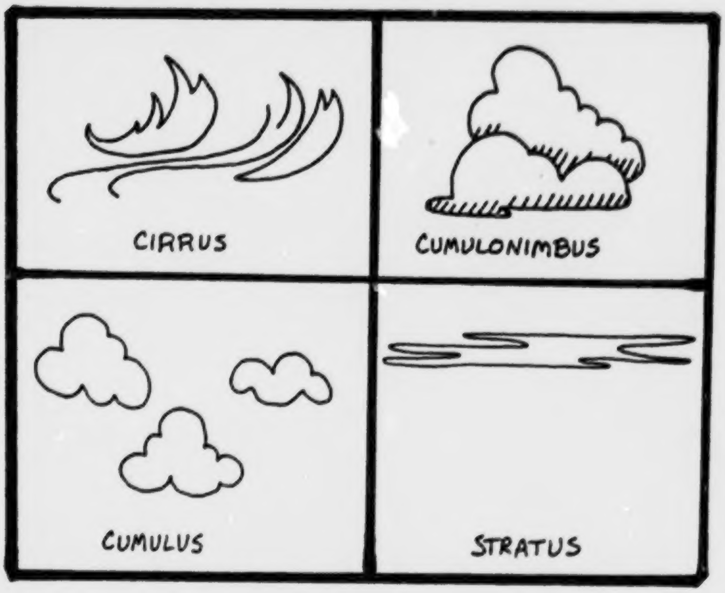
5. Tape a magazine picture of a cloud to each of 4 big sheets of paper. Try to get pictures of a variety of cloud types. Let students draw similar clouds around the magazine picture.

6. Discuss the types of precipitation that come out of the types of clouds represented. Have students draw one type of precipitation coming out of their cloud. Tape all four murals on the wall and discuss the differences between the clouds drawn, and the types of precipitation that the students drew.

EXTENSIONS:

1. Cloud Fingerpainting: Do cloud fingerpainting on blue construction paper. White finger paint can be made by mixing the soap flakes and laundry starch, and adding water until the mixture is very thick.

2. Cotton Clouds: Cut cloud shapes out of tag board. Students can paste cotton balls on these shapes. Varying the thickness of cotton balls will create different cloud types.



BACKGROUND:

Water enters the atmosphere through the processes of evaporation and transpiration. Evaporation is the process whereby liquid water is turned into water vapor by heat from the sun.

Two things are needed for clouds to form: small solid particles in the atmosphere, and rising air. The particles are needed for the water vapor to condense on and are called "condensation surfaces." Dust, sea salt and smoke particles are common condensation surfaces. When air rises, it expands and cools. If the air cools enough and there are condensation surfaces present, a cloud is born.

Clouds differ in appearance mainly due to the conditions under which they were formed. There are three basic types of clouds: stratus, cumulus, and cirrus. Stratus-type clouds, which appear flat, layered, and blanket-like cover large portions of the sky. They are formed when a large air mass moves upward slowly, and condensation occurs throughout the air mass. These clouds often indicate there will be some precipitation soon, probably in the form of a long, steady rain or snow.

Cumulus clouds generally look like pieces of puffy cotton spread across the sky. They are formed as uneven heating of the earth's surface takes place. In spots where the surface is heated, a smaller mass of air will rise up like a bubble. These may be called "fair weather cumulus" because they often indicate sunny weather. However, when many cumulus clouds collect together to form a large, tall cloud mass, and this cloud mass is surrounded by cooler air, a cumulonimbus, or thunderhead, is formed. This type of cloud is associated with quick, often violent thunderstorms.

The third cloud type is cirrus. Cirrus clouds are the high, wispy clouds. They appear in dry weather and indicate that the weather will change soon and possibly that a storm is coming.
The clouds complete the water cycle by sending water back down towards the earth in the form of precipitation.

Water, Visible and Invisible:

Condensation and evaporation

SUMMARY: Through observing the condensation of their breath, and evaporation of water from a chalkboard and two sponges, students experience evaporation and condensation as important parts of the water cycle.

OBJECTIVES: To observe and explain condensation and evaporation. These two concepts are important to the water cycle.

VOCABULARY WORDS: cloud, evaporation, condensation, water vapor, rain, sleet, hail, snow, liquid, gas

TIME REQUIRED: 15 minutes

MATERIALS NEEDED:

Chalkboard
2 Damp sponges
Window or mirror

PROCEDURE:

1. Ask students when they can see water droplets *(Raindrops are one kind of water droplet, but there are smaller ones, too, such as those that form clouds, the "steam" rising from a hot dinner, and the visible water droplets that can be seen when students breathe out on a cool day.)* This is one form of water. Water vapor is another form of water. Water vapor is the invisible, gaseous state of water and is in the air all around us. Invisible water vapor can change form from its gaseous state, water vapor, into its visible liquid state: water droplets. When this happens, it is called condensation. Clouds are formed from water vapor which has condensed into visible water droplets.

2. Let students breathe out onto a window or mirror. The invisible water vapor in the moist air that has come from their lungs will appear as visible water droplets on the surface of the window or mirror. This is called condensation. After a few moments, the visible water droplets will then disappear through evaporation: they go up into the air as invisible water vapor.

3. Explain that the water droplets that form when they breathe out onto cold glass are from their own moist breath. Warm, moist air floats up or rises because it is lighter than heavier, cooler air.

4. Tell students to put one of their hands up to their mouths and breathe on it. It will feel warm and moist. Where does the moisture they feel on their hand go? *(Into the air as invisible water vapor.)*

5. Tell students that one of them is going to wipe the chalkboard with a wet sponge. Ask them to predict:

a) Will the chalkboard dry by itself?
b) How long will the chalkboard stay wet?
c) Will the wet sponge dry by itself?

6. Have one student wipe the chalkboard with a wet sponge. Observe what happens and compare the results with the predictions of the class. Where did the water that was on the chalkboard go? *(Into the air as water vapor.)* Where will the water in the sponge go? *(Into the air as water vapor.)*

7. Wet 2 sponges. Place one sponge in sunlight or over a heating vent, and the other sponge in a shaded or cool area. Ask the students which sponge they think will dry faster. Where will the water go? *(Into the air as water vapor.)* Will they be able to see the water as it leaves the sponge? *(No, water vapor is invisible.)*

8. Discussion Questions:

a) When does condensation happen in the natural world? *(Clouds, precipitation, dew, etc., all occur as a result of condensation.)*

b) When does evaporation happen in the natural world? *(On warm days, water vapor escapes from lakes, ponds, streams, and puddles; plants bring water up into openings in their leaves, where it evaporates [called transpiration].)*

c) What if there were no condensation and evaporation?

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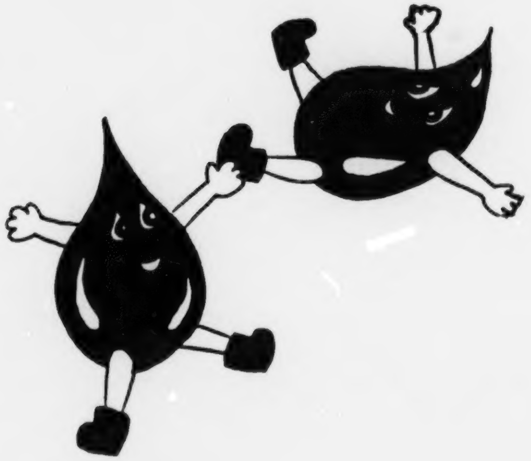
(There would be no clouds, no rain or other precipitation, no dew, etc. Condensation and evaporation are important parts of the whole water cycle.)

9. Later, go back and compare the two sponges.

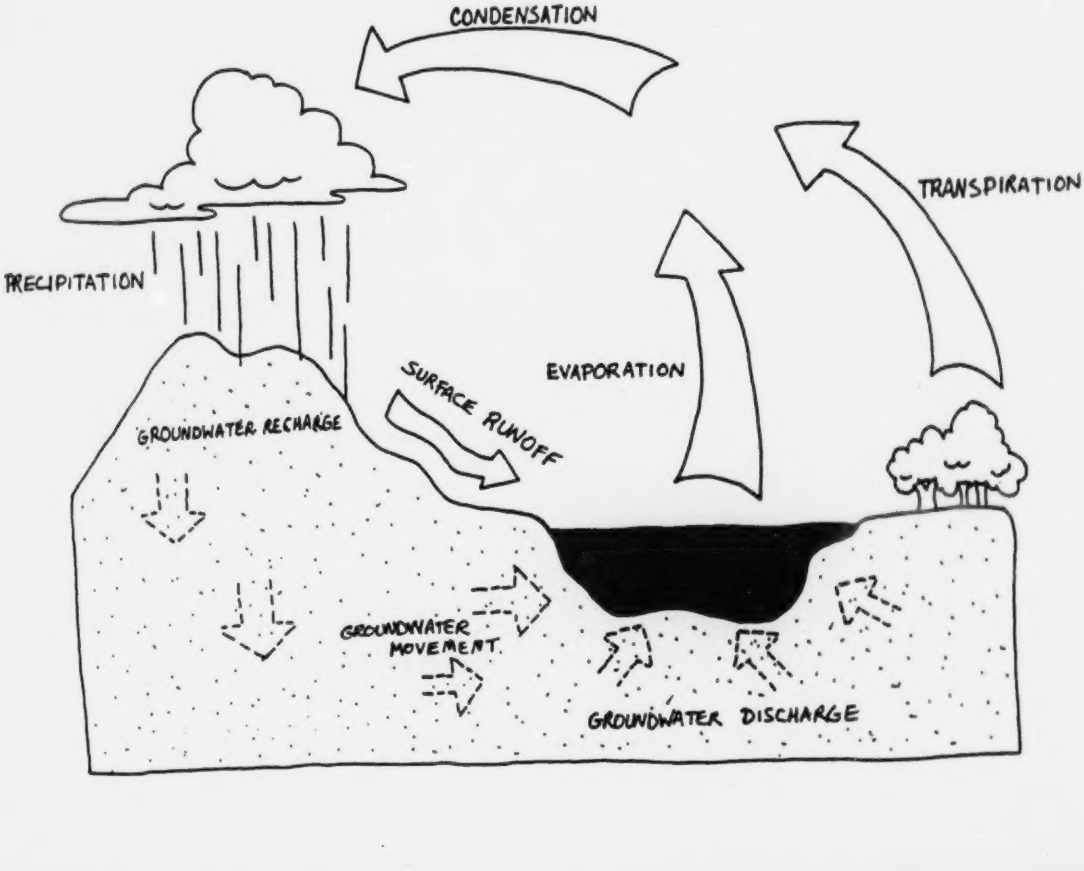


BACKGROUND:

Water makes its way into the atmosphere through the processes of evaporation and transpiration. Evaporation is the process in which liquid water is turned into gaseous water vapor by heat from the sun. The liquid water may come from oceans, lakes, streams, precipitation, soil moisture, or groundwater.

Transpiration is a process similar to evaporation, whereby plants give off water vapor during the process of photosynthesis. When water vapor is cooled sufficiently, molecules go from gas to a liquid state. This is called condensation, and is seen as rain, hail, sleet, dew, etc.

Both evaporation and condensation depend partly on air temperature. Although other factors come into play, a general rule is that cooler air holds less moisture.


CONDENSATION
TRANSPIRATION
PRECIPITATION
EVAPORATION
SURFACE RUNOFF
GROUNDWATER RECHARGE
GROUNDWATER MOVEMENT
GROUNDWATER DISCHARGE

Pen Pals:

Michigan's weather and water

SUMMARY: Students can discuss differences in weather and climate, groundwater and surface water sources, and water uses with pen pals in various geographic areas of Michigan.

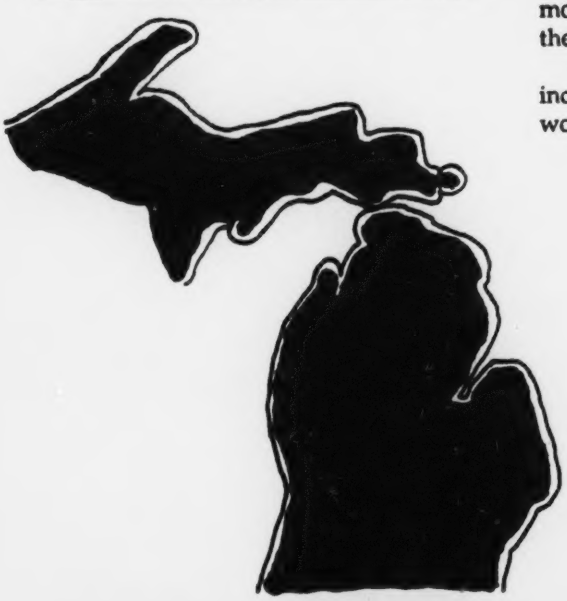
OBJECTIVE: To make students aware of water and weather situations in other locations.

VOCABULARY WORDS: pen pal, climate, location, region

TIME REQUIRED: Six 20-minute periods, over 2-9 months

MATERIALS NEEDED:

Pen pal(s) through the Ecology Center or other source
Writing paper, pencils
Drawing materials
Map of Michigan
Postage stamps
Funnel (optional)
Coffee can, plastic milk jug with top cut off, or mason jar (optional)



PROCEDURE:

1. Contact the Ecology Center of Ann Arbor at 417 Detroit St., Ann Arbor, MI 48104, (313) 761-3186 to arrange for one pen pal for your class or one pen pal for each student. Ask for a class from a different region in Michigan. Below are some ideas for topics on which to correspond.

a) For a first contact, have students draw a simple map of Michigan, locate their community on it, and introduce themselves to their pen pals.

b) Students draw a picture of where their water comes from and/or goes after use. Does it come from under the ground (groundwater) or the surface (a lake, river, or impoundment)? Send this to pen pals and request a similar picture back.

c) Students describe this week's weather to their pen pals, and request that their pen pals describe the weather that they are experiencing.

d) Students make lists of who uses water in their community (farmers, industries, residents, corporations, etc.), and where they get their water from (groundwater or surface water). Send the lists to the pen pals, and ask them to send a list of water users and sources in their community.

EXTENSIONS:

1. Set out a simple "rain gauge" in an area with no roofs or overhanging trees, and out of the way of children at play or walking to and from school. Have students record the amount of rainfall they get on every rainy school day for a month. At the end of the month, they can draw bar graphs of the rainfall amounts, and ask their pen pals how much it rains where they live.

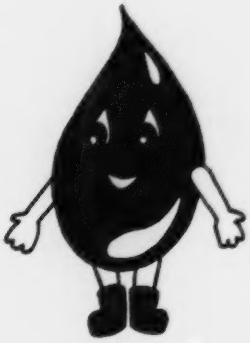
2. Pen pal communication could eventually be expanded to include students from other parts of the country or from around the world.

BACKGROUND:

One of the best means of learning about a subject is by sharing information with others, and hearing what they have to say in reply. Pens pals are a terrific way of reaching people who live in different areas and have a different way of life, attend a different school, live in areas that are different geographically, have different weather, or experience any other kind of contrast. We can also learn personal information, such as interests, hobbies, etc.

The same holds true for learning about Michigan's groundwater. Water availability varies according to temperature, wind, rainfall and geological formations. For example, a shallow aquifer in an area of substantial rainfall can replenish itself almost immediately, whereas an aquifer in a region with slight precipitation may take centuries to refill.

Annual precipitation in Michigan ranges from 28 to 38 inches (71 to 97 cm), and varies in different parts of the state. For instance, the western side of the lower peninsula has high precipitation, ranging from 30 to 38 inches (76 to 97 cm) yearly, while the northeast shore of the lower peninsula along Lake Huron receives only 26 to 28 inches (66 to 71 cm) per year.



SECTION 3

WHERE IS WATER FOUND UNDERGROUND?

Where Did It Go?:

What happens after water hits the ground?

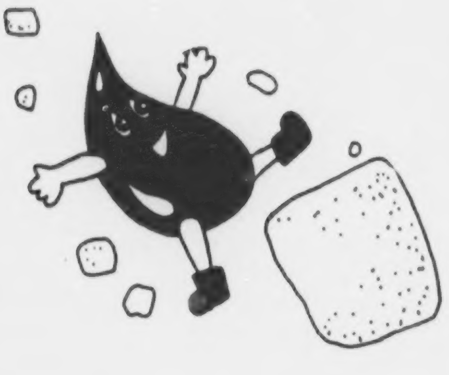
SUMMARY: Students closely examine a container of earth materials, predict where water poured on it will go, and then observe that water goes between the particles of the material.

OBJECTIVE: To demonstrate how water fits underground.

VOCABULARY WORDS:
sediment, aquifer, sand, gravel, rocks, clay

TIME REQUIRED: 20 minutes

MATERIALS NEEDED:
1 Large container of lightly-colored sand
1 Large container of gravel or small rocks
1 Clear glass or plastic container for each group of 3-5 students
1 Cup or measuring cup containing dyed water for each group of 3-5 (green food coloring works well)
Measuring cup
1 Worksheet for each student
Drawing materials
Magnifying glasses (optional)



PROCEDURE:

1. Pass around containers of sand, and gravel or rocks. Discuss how they differ from each other. *(Differences may include color, smell, weight, particle size, hardness, etc.)*

2. Divide the class into groups of 3-5 students.

3. Provide each group with a clear plastic container and a worksheet.

4. Let each group measure with a measuring cup a given amount of one of the materials, and place it in their container. The amount should be enough to fill the container halfway or more. (Option: each group can work with two containers—one of each material; or each student can have their own container of material.)

5. Ask students to "be a microscope" and look very closely at their container of material. (Optional: use magnifying glasses.) Then, on the "before" side of the worksheet, each student should draw a picture of their container of material.

6. Have students predict what will happen when water is poured into their container of material. Where will the water go? Older students can write down their prediction on the worksheet.

7. Provide each group with a given amount of dyed water (the amount should be enough to nearly fill the container of material). Allow students to pour the water into the containers, and observe closely what the containers look like before, during, and after the water is poured into them. Each student in the group can pour part of the water.

8. Each student should draw the container of material with water in it on the "after" side of the worksheet.

9. Discussion questions:

a) Where is the water that was poured into the containers? *(Between sand or gravel particles or between rocks)*

b) What was between the particles or rocks before the water was poured on them? *(Air)*

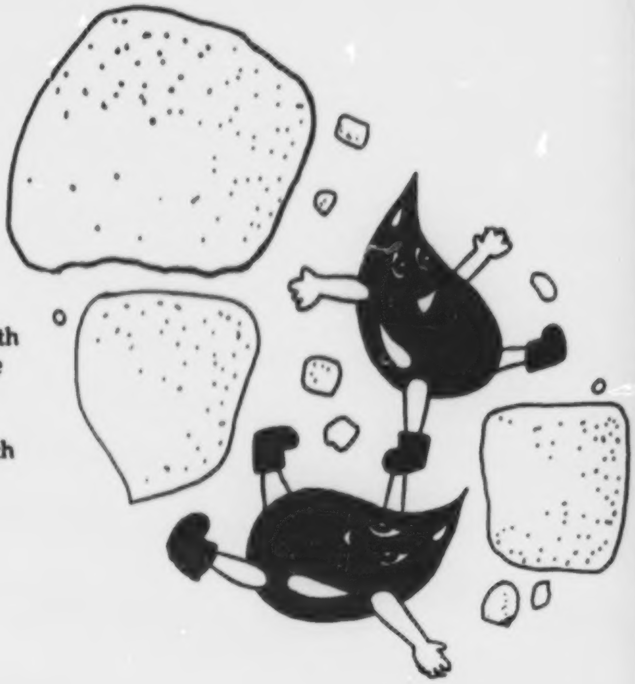
c) In which container can you see the least amount of water? *(Sand)*

d) Where is the water in the container of sand? *(Between particles)*

e) The ground at students' homes and schoolyard is made out of a mixture of the same types of materials as those in their containers. What happens to water when it rains on ground made of sand, gravel, or rocks? *(Some of it goes in between the particles, just as can be seen in the containers.)* When water is stored underground like this it is called groundwater.

f) Discuss with students the fact that half of the people in the U.S. use groundwater to drink, and in their homes. List some water uses.

BACKGROUND:



In order to gain a better understanding of groundwater, it is helpful to learn how water moves through earth materials into the ground. Characteristics of earth material can have a profound effect on how water moves into the ground.

Earth materials are made up of all different shapes and sizes of particles. When water hits the ground, it is able to seep into the spaces, or pores, between these particles. If many pore spaces are present, the material is capable of holding large amounts of water and is said to have high porosity. Sand is one example of a highly porous material.

Well-connectedpores will allow water to move easily. Earth materials with well- connected pores are said to be permeable. The size and shape of clay particles, and the arrangement of the pores between the particles impede the passage of water, and make its permeability very low. In contrast, highly permeable materials such as sand and gravel are very permeable, and allow water to move through easily and rapidly.

ACTIVITY 3A WHERE DID IT GO? WORKSHEET

Before

After

Water on Your Playground:

When does water sink in?

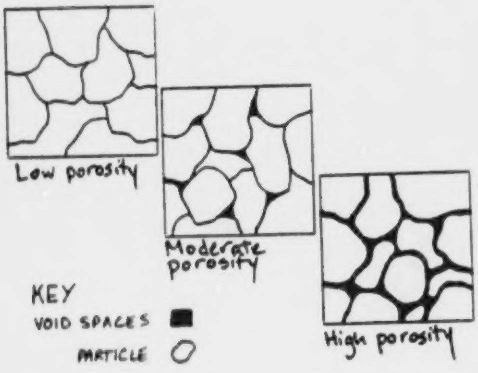
SUMMARY: Students observe patterns of water travel on their school grounds. Optional activities include a visit from a county agent or volunteer to bring up a soil sample with an auger from the schoolyard, and writing away for soil samples from different counties in Michigan.

OBJECTIVE: To make students aware of their immediate surroundings through questioning, observing, predicting, and categorizing.

VOCABULARY WORDS:
groundwater, auger, sediment, erosion, county

TIME REQUIRED: 25 minutes

MATERIALS NEEDED:
3 Cups of water
List of Soil Conservation District addresses in Michigan (optional)
1-2 Postcards or envelopes, stamps, and baggies per student (optional)
Michigan map (optional)



PROCEDURE:

1. Take students for a short tour of the playground to look for gutters, slopes, grates, drains, and other things that might influence water flow. Ask students to describe the characteristics of water on the school playground. Where is there evidence of water on the playground? *(There may be places where puddles always form, areas where sediment erosion is visible, gutters to channel water, manholes with pipes under them, moist areas covered with vegetation, etc.)*

2. Go out to the playground with three big cups of water. Pour one onto the asphalt or concrete, one onto some moist ground, and one onto well-traveled ground, like a dirt path. Observe where the water flows.

3. Discussion questions:

a) Where does rain that falls on the asphalt go? *(Probably down a grate, into a storm drain, and into a nearby river or recharge basin.)*

b) Where does rain that falls on the moist ground go? *(It may seep into the ground, joining other water in the ground [groundwater]. It may be used by plants while it is still near the surface. If the ground is very moist and already holding as much water as it can, the rain may puddle on the surface of the ground.)*

c) Where does rain that falls on the well-traveled area go? *(It may puddle up, run off, or soak into the ground very slowly.)* Why is this different from the rain that falls on the moist ground or asphalt? *(Since the sediment particles have been packed tightly by the pressure of many little feet, there is no longer a lot of space between the sediment particles through which the water can go. But, there are still more spaces between sediment particles in the tightly-packed dirt than there are in the asphalt. This is why water may run off of the well-traveled area more slowly or be absorbed by the soil more than it does in the asphalt or concrete area. Run-off also depends to a certain extent on the slant of the ground.)*

EXTENSIONS:

1. Call your local Soil Conservation District office (see appendix) or your County Cooperative Extension Service's Master Gardener program. Arrange for a Soil Conservationist or volunteer to come visit your class with an auger, and bring up a soil boring on the playground. Observe the work with the class.

a) Discussion Questions:

1) What did the auger bring up?

2) Are there different types of soil in the boring, or is it all one type? *(The agent will be able to help the class identify different types of soil in the boring. Let the students touch the soil, feel how moist it is, and observe the sizes of soil particles.)*

3) Would we find the same types of soil no matter where we did the boring? *(No, soil types differ greatly from location to location.)*

b) With the class, pour water in the hole until it is full. Watch for a few minutes to see if water seeps into the ground immediately. If not, cover the hole with a board or rock and return

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in a few hours and/or the next day to see if the water level in the hole fluctuated.

c) Discussion questions:

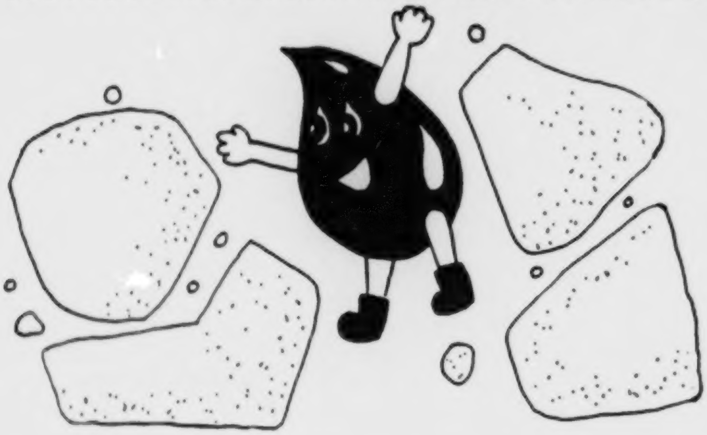
1) Did the water level go down? If so, where did the water go?

2) Into which types of soil layers did the water most likely seep? *(Usually, gravel, sand, and loam will more readily accept water than will clays.)*

3) Why do some types of soil more readily accept water? *(Because they have the largest and best-connected air spaces between their soil particles. The water moves through air spaces.)*

2. Have each student write postcards or letters to one or two of the Soil Conservation District offices in Michigan (see appendix). Ask for a typical soil sample from each district. If letters are sent, enclose a small plastic bag for the office to send the sample back in. Display samples in the classroom as they arrive, and locate the district on the map. Postcards or letters can read:

> Dear Madam or Sir,
>
> I am writing to you from _________ (school) in _______ (county). My class is learning about soil and water. Could you please send us a small amount of one kind of soil that you have in your county? The address of my school is:
>
> Yours,
>
> _______(student's name)



BACKGROUND:

When water in the form of precipitation falls on the earth, it may soak into it, move across it, or a combination of these two. The process of water soaking into the ground is called infiltration; the process of water moving across the ground is called run-off. Plants also may intercept some of this water, using it for their own needs.

Several factors influence the rate and amount of water that infiltrate the earth. Earth materials are made up of tightly packed particles which can be of many shapes and sizes. As water reaches the land surface, it can seep downward through the pores between soil particles. Depending on the amount of space between the particles (the porosity) and how well-connected those spaces are (the permeability), the water will infiltrate faster or more slowly. Sands and gravels allow more rapid infiltration than do clays due to higher permeability.

Human activities also affect permeability. When soil gets compacted, the soil particles get pressed closer together, thus reducing permeability. Paving also reduces the permeability; in fact, there is often no infiltration into a paved surface (unless the pavement is broken open).

The initial water content of the soil is also important. In general, water infiltrates drier soils more quickly than wet soils. The intensity of a storm, or the length of time during which precipitation occurs, can also influence infiltration. If rain or snowmelt reaches the soil surface faster than it can seep through the pores, then the water pools at the surface, and may run downhill to the nearest stream channel.

In terms of human retrieval of groundwater, permeability is very important. Some materials that are very porous are not very permeable, like clay. This means that even though the material may be holding a lot of water, the water will only come out very slowly—too slowly to be useful.

Ground *What?* Groundwater!:

How water fits underground

Adapted with permission from "What Is Groundwater?", *Groundwater Quality Protection in Oakland County: A sourcebook for teachers, East Michigan Environmental Action Council, Birmingham, MI, 1984*

SUMMARY: Students, working in groups, build a simulated aquifer, identify the water table, and learn how water is stored underground.

OBJECTIVES: To explain that groundwater fills the spaces between particles, and to learn about the water table.

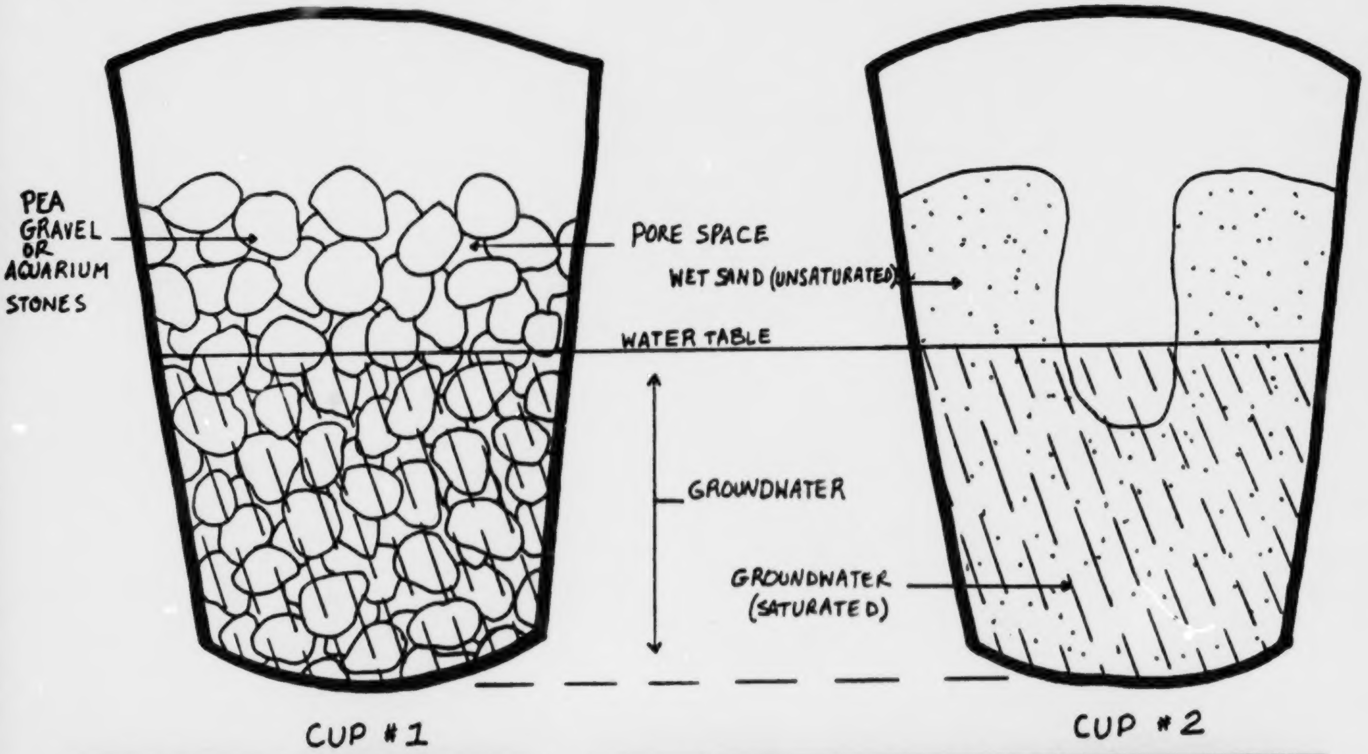
VOCABULARY WORDS:
groundwater, water table, saturated

TIME REQUIRED: 20 minutes

MATERIALS NEEDED:
Each group of 3-5 students needs:
1 Clear cup filled to the top with pea or aquarium gravel and half-filled with water
1 Clear cup filled halfway with sand
1 Cup filled 1/3 with water
1 Crayon or 2 pieces of tape

PROCEDURE:

1. Divide students into groups and hand out cups containing gravel and water. Ask students to examine the material in their cup and describe where the water fits in it *(between gravel particles)*. Explain that water found in the ground is groundwater. This is like the water found under the earth's surface.
2. Have each group find the top of the water in the cup, and using a crayon or piece of tape, mark it on their cup. Explain that this is the water table.
3. Distribute one cup of sand, and one cup of water to each group. Have students examine the sand for things like particle size, color, texture, etc., and share their observations with their group.
4. Students should slowly pour the water into the cup of sand. Those not pouring should be carefully observing where the water goes. *(It fills up the spaces between the sand particles.)* They should also watch for the telltale bubbles of air that may form as air is being forced out of the spaces between particles by the incoming water.
5. Ask students to mark the water table in the cup of sand and water with a crayon or tape.
6. One student in each group should make a hole in the sand with their finger or a pencil. A small pool of water will form in



the hole. The top surface of the water in this pool is the water table.

7. Have students feel the sand on the top. How does it feel? Why? *(The sand at the top of the cup is dry or damp. It is not saturated, like the sand under the water table.)*

8. Have students poke a hole in the bottom of their cups, and let the water drain out the bottom. Then, feel the sand. Is it dry or damp? *(Damp)* Why? *(Because some water sticks to the grains of sand.)*

9. Discussion Questions:

a) What happens to the water that comes down when it rains or snows? *(It runs off into lakes or ponds, evaporates into the air, or sinks down into the ground and travels to the water table. In Michigan, about 30% of precipitation reaches the water table.)*

b) What was between the sand or gravel particles before water was poured into the cups? What is between sediment particles underground if there is no water there? *(Air, which is displaced by the water.)*

c) How far underground is the water table? *(The depth of the water table varies with the area. In most lakes and streams, the water table is visible to people. In other places, it can be just a few to several hundred feet under the ground.)*

d) Why is a water table important to life on Earth? *(People use wells to reach the water table and draw up water. When the water table is at the surface, as with lakes and streams, all the plants and animals in the lake or stream depend on the water in the water table to exist in their habitat.)*

BACKGROUND:

When water hits the ground, gravity pulls it through the pores in the soil until it reaches a depth where all of the spaces between the particles are filled with water. The water level at this point is called the water table. The water table can be affected by various factors. It can rise during high periods of rainfall, and fall during a drought.

Below the water table, all the spaces between particles are filled with water, also known as groundwater. When there is an underground, saturated, permeable, geologic formation capable of producing significant amounts of water in a well or spring, it is called an aquifer. There are two types of aquifers.

Nearly 90% of all aquifers developed for water supplies are composed of sands and gravels. Porous sandstone, limestone and highly- fractured crystalline and volcanic rock are other common aquifer materials.

SECTION 4

HOW DOES WATER MOVE UNDERGROUND?

Creating with Clay:

How is clay different from other sediments?

SUMMARY: Students mold clay into different shapes, and observe how well clay cups hold water.

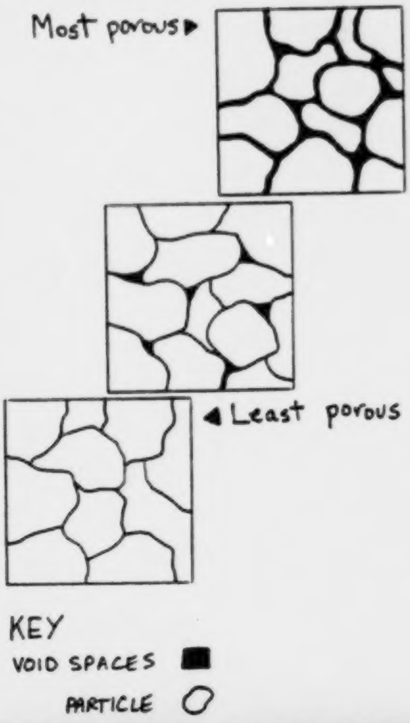
OBJECTIVE: To show that water does not flow easily through clay.

VOCABULARY WORDS: gravity, gravel, clay

TIME REQUIRED: 25 minutes

MATERIALS NEEDED:

Clay
Sand
Gravel
Plastic straws, toothpicks, or pencils
Water
2 Plastic flowerpots with holes in the bottom
A 6-inch stack of glossy newspaper circulars and/or magazines



PROCEDURE:

1. Give each student or group of students some clay to work with. Their task is to make a container that will hold water.

2. When they are finished creating, have students hold their containers over a dishpan or bucket to catch water if needed. Let them pour a small amount of water into their cups and observe what happens. If their container does not hold water, give the student a chance to fix the container and try again.

3. Now have students half fill their container with sand or gravel. Pour a small amount of water into each container. Where does the water go? Does the cup still hold water?

4. Have students hold their container over something, and poke a hole in it with a toothpick, pencil, or straw. What happens?

5. Discussion Questions:

a) Describe what happened when water was added.

b) Does the water move up or down? *(Down)*

c) Why? *(Gravity pulls everything down.)*

d) Does the sand or gravel stop water from moving? *(No, they sometimes slow it down.)*

e) Does the clay stop water from moving? *(Yes)*

f) Can water move through the clay cups? *(Only through the straws, openings, or holes in the clay cups.)*

g) Why is clay different in this way than sand or gravel? *(Because clay particles are packed together tightly to keep water from getting through. Sand and gravel have big particles, and are not packed together as tightly, so they still let water through.)*

6. Have students fill one plastic flower pot with crumpled glossy paper. Wads of newspaper are like the bigger sand and gravel particles.

7. Have students rip the glossy paper into strips. Tear the strips into pieces about 4" long (so that they can lie flat in the flowerpot). Fill a second plastic flower pot with the pieces of glossy paper, laid flat on top of one another. Strips of paper stacked on top of each other are like the clay particles, which pack tightly together.

8. Pour equal amounts of water into each pot. Record the amount of time that it takes for the water to begin to drip out of the holes at the bottom of each flower pot.

9. Discussion Questions:

a) Which pot did the water move through more quickly? Why? *(The pot with crumpled newspaper. Because the wads of newspaper are rather large, and because they don't stack very tightly, there are large air spaces between the "particles." The water flows through these air spaces.)*

b) Which pot did the water move through less quickly? Why? *(The pot with layered strips of paper. This is because the paper strips are thin, and therefore stack very tightly. There is very little room for the water to move between the strips. The water must zigzag through very narrow spaces.)*

c) Which pot is most like a cup full of sand or gravel? Why? *(The one with wadded-up paper. Sand and gravel particles are rather large,* *irregular in shape, and don't stack very tightly.)*

d) Which pot is most like a clay cup? Why? *(The one with layered strips of paper. Clay particles are very thin, like the strips of paper, and stack together very tightly.)*

e) What would happen if you poured water on ground made of sand or gravel? *(The water quickly goes down through the openings between the particles.)*

f) What would happen if you poured water on ground made up of clay? *(Most of the water would form a puddle on top of the clay, some would very slowly soak into the ground, and some would evaporate.)*

EXTENSIONS:

Used with permission from draft Classroom GEMS K-3 curriculum, Pellston, MI, 1990.

1. Have students sit very closely together, like clay particles, then far apart like gravel. Notice the difference in spaces between each particle (student) in the two types of sediment.

2. Give each student a paper cup with a small hole in the bottom. Have them work in pairs. Provide them with sand, gravel, and clay. Tell them they are preparing for 2 races. The first contest will be to judge whose cup allows water to move through most quickly. The second contest will time water moving the slowest through their cups. Each team should write their names on the cups, and prepare one cup for each contest.

a) Students should draw pictures of their 2 finished cups, showing layers of sand, gravel, and/or clay.

b) The races should be set up on newspaper to enable the class to see the water easily when it comes through. The races should be done in "heats," with 5 contestants in each heat. The fastest in each heat will then compete with the other heat winners for the fastest overall. You may end up with numerous contestants in a tie if they all have gravel cups.

c) Compare the drawings of the fastest cups. What do they have in common? Does water move through sand and gravel at different rates?

d) The slow race should be set up on trays lined with newspaper, since the results may take much longer. Students can pour half a cup of water in to start. Have them make observations for the first full minute, then again at 2, 3, 4, 5, and 10 minutes. Then make observations at scheduled times (such as twice a day) for the next two weeks. If all the water is gone from the surface, but not yet coming out of the bottom, students can add an additional half cup.

e) After the final observations, compare the drawings of the slowest cups. What do they have in common?

BACKGROUND:

By looking around the neighborhood, we can easily find soil and rock that consist of different sized particles. Earth materials that range in size from the smallest particle of clay, to larger particles of sand, to the largest particles of gravel and rocks, are all easy to find in southeast Michigan. Soil found near the surface develops certain characteristics as plants impact upon it over the centuries. Glacial till, found below soil horizons, came about as a result of the movement of glaciers over Michigan tens of thousands of years ago, during the last Ice Age. The glaciers' slow, grinding movement churned up the earth and changed it drastically, crushing stones and transporting their fragments.

The rate at which water flows through different earth materials can be explained by examining two important concepts: porosity and permeability. The porosity of a material is the ratio of the volume of a material's pores to that of its total volume. The amount of water stored in pore spaces between particles can depend on the size of the particles themselves. Permeability is a measure of the rate of flow of a liquid through earth materials, and is dependent on the interconnectedness of the pore spaces within any earthen material. Materials that have well-connected pore spaces will let water through much more easily than those in which pore spaces do not connect well.

Clay-rich soils will not allow water to flow through easily, because of the limited connectedness between pore spaces. Part of this is the result of the plate-like shape of soil particles, which stack together tightly, leaving poorly connected pores for water to move through. Soils in Michigan vary in their permeability. Some materials, like clay-rich soils, can only accept .1 to .6 inches (.3 to 1.5 cm) of water per hour. Others, such as sandy soils, can accept more than 20 inches (51 cm) of water per hour. Because of these factors, students can shape water-holding cups from clay, without having water flow through the sides of the cup. A clay layer found over a groundwater source is viewed as a useful protector of the underground water resource. Clay is also used as a liner under potential groundwater contamination sites such as landfills.

Water's Journey in a Jar:

An experiment showing how water moves

SUMMARY: Through placing different earth materials in plastic soda pop bottles, this activity illustrates that the ground is made up of layers of different sediment types. Water movement through the layers is observed. The first portion is a teacher demonstration. The second is a student activity.

OBJECTIVES: To describe and define groundwater. To show that different types of layers occur underground, and to describe how water fits underground and moves through these layers due to gravity.

VOCABULARY WORDS: layers, gravity, groundwater, gravel

TIME REQUIRED: 45 minutes

MATERIALS NEEDED:

A 2-liter soda pop bottle with the cap tightly screwed on and with the bottom half cut off
6 Clear plastic cups
Food coloring and water
Approximately 6 cups each of rocks, gravel, sand, and/or schoolyard sediment (preferably all lightly-colored)
6 Two-inch diameter balls of clay (regular or modeling clay)
1 Square foot cheese cloth, or some old nylon stockings, cut into four squares or circles (to separate sediment layers in Part I)
5 One- or Two-liter plastic soda pop bottles with caps tightly screwed on and with the bottom halves cut off
5 Small pieces of aluminum foil or plates
Measuring cup
The pump from a squirt bottle (optional)
Drawing materials

PART I: TEACHER DEMONSTRATION

PROCEDURE:

1. Cut the bottom half off a 2-liter soda pop bottle. Make sure the bottle is tightly capped. Fill the upside-down bottle with layers of different earth materials such as rocks, gravel, sand, schoolyard sediment and clay. Separate the layers with cheesecloth or pieces of an old nylon stocking so that they will be easy to remove one layer at a time later in the activity. Use lightly-colored earth materials if possible. The bottom layer (closest to the bottle's top) should be made of clay, and touch all the way around the bottle. Poke a small hole in the clay at some point. Rest the upside-down soda pop bottle and its contents in a cup. (See diagram)
2. Dye some water with food coloring. Green works well. In clear view of the class, very slowly add the colored water.
3. Have students observe the water moving through the layers as you pour it very slowly into the soda pop bottle.
4. Discussion Questions:
   a) What do you see?
   b) Where does the water go?
   c) Where is the water right now? *(In the spaces between the particles of rock, gravel, and sand)*
   d) What layers does the water go through easily? *(Rocks, gravel, and sand)*
   e) What layers does the water have difficulty getting through? *(Clay)*
   f) Why does the water try to make its way to the bottom of the soda pop bottle? *(Gravity)*
   g) In what ways is this soda pop bottle like the Earth? *(There are different kinds of sediment underground, water underground, water falling on the sediment is like rain, etc.)*
   h) In what ways is this soda pop bottle unlike the Earth? *(There are things growing on the Earth's surface, the ground goes down farther than the soda pop bottle, etc.)*
   i) What is groundwater? *(Water in the saturated ground.)*
5. Optional: Get a pump from a squirt bottle. Push the tube down into your container. Make sure that the bottom of the tube rests against a solid area surrounded by water. Pump until the water comes up the tube, and squirts out, representing a well.
6. Over a bowl or other container, unscrew the bottle cap to let students see if water was able to get through the clay layer and drip out the spout of the bottle.
7. Disassemble the layers by picking up the separating pieces of nylon or cheesecloth one at a time, putting each on a separate piece of foil or plate.
8. Let students feel these different sediment types, keeping in mind the questions: How wet is it? Is the water inside the rocks, gravel, clay, or sand, or on the outside of them?

PART II: STUDENT ACTIVITY

PROCEDURE:

1. Divide the class into five groups of students. Give each group a 1- or 2-liter plastic soda pop bottle with the bottom cut off, and two or more types of earth materials in separate containers. Leave the bottle cap tightly screwed on.

2. Let students touch and hold their earth materials.

3. Discussion Questions:

a) What does each type of sediment feel like?

b) Which has the biggest particles? *(Rocks)*

c) Which has the smallest particles? *(Clay)*

d) Which stick together when squeezed? *(Clay, and maybe schoolyard earth materials)*

4. Each group puts sand, gravel, rocks, clay, and/or schoolyard sediment into their upside-down bottle. The order of each group's layers should be unique, but all groups should put a layer of clay at the bottom of their upside-down bottles.

5. Have the groups draw a picture of their bottles with the layers, and label the layers on the drawing.

6. Each group slowly pours 1/2 to 1 cup of water with food coloring into its upside-down bottle, observes what it sees happening, and records its observations. (Optional: Give each student group just one sediment type, and have them measure the amount of time that it takes for water to go through the materials.)

7. Optional: After a few minutes, let groups come up one at a time to a bowl in the front of the room. They can then take off the bottle cap while holding the bottle over the bowl to see whether the water eventually traveled through the clay.

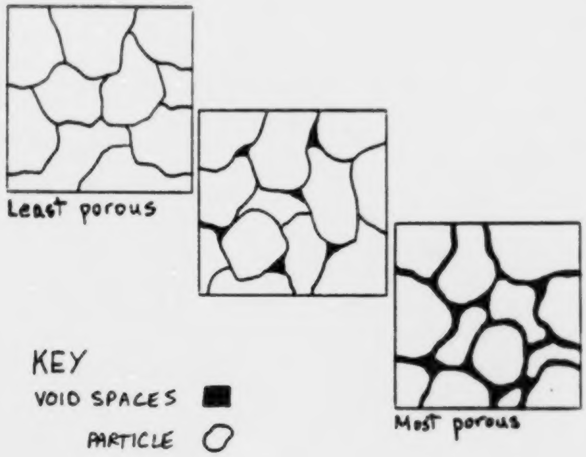
8. Discussion Questions:

a) Where did the water collect or stop?

b) Why did it stop or collect in those places?

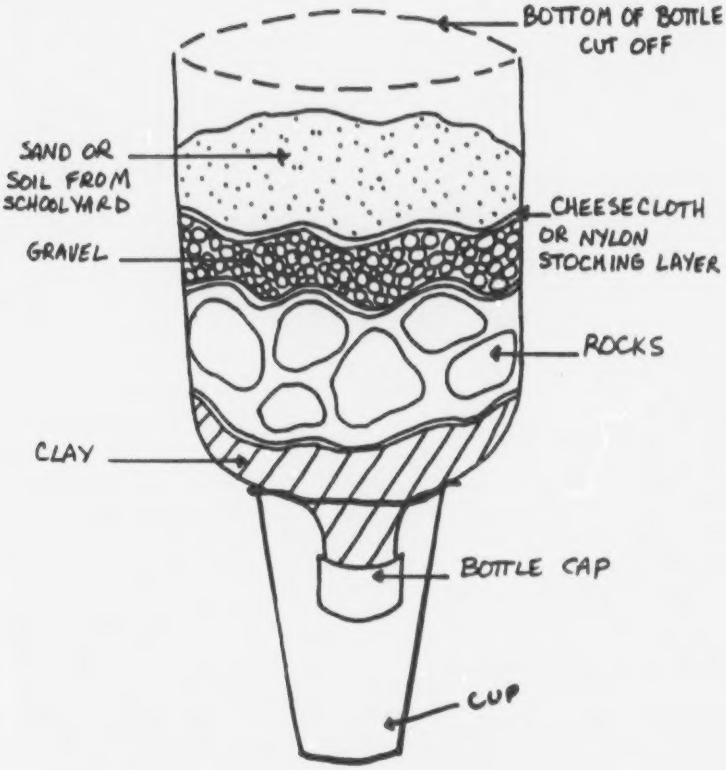
c) Where does the most water fit?

d) What do you think would happen to the water if it sat in the bottle over time?



BACKGROUND:

Groundwater is constantly moving. The rate of movement can be very slow or very fast, depending on the types of earth materials that are present. It can move as fast as 50 feet (15 m) per day in coarse gravel, but in clay it may take 500 years to move 50 feet. For example, a U.S. Geological Survey study determined that groundwater near Traverse City, MI was moving at a rate of 3 feet (.9 m) per day in an unconfined sand and gravel aquifer. The horizontal movement of water through the ground also depends on the type of bedrock formations that are present. For example, if the pores in sandstone are connected, water is easily transmitted, and the rock is said to be highly permeable. Limestone may be fractured with many cracks that are connected, and can also transmit water easily, while such fine-grained rocks as shale and slate have low permeability.


BOTTOM OF BOTTLE CUT OFF
SAND OR SOIL FROM SCHOOLYARD
CHEESECLOTH OR NYLON STOCKING LAYER
GRAVEL
ROCKS
CLAY
BOTTLE CAP
CUP

Wiggling Water:

A new groundwater game

SUMMARY: By simulating water droplets and sediment types, students discover in a physically active way how hard it is for water to get through different materials.

OBJECTIVE: To demonstrate that water moves easily through some sediment types, and with great difficulty through other types.

VOCABULARY WORDS: droplet, gravel, formation, sediment
TIME REQUIRED: 15 minutes
MATERIALS NEEDED:
Some open space in a classroom, gym, or outdoor grassy area
A closed jar of gravel, a closed jar of clay, and a rock (for Grades 2-6)
A closed jar of sediment and rock (for Grades K-1)
A clock or watch (optional)

PROCEDURE:
FOR GRADES K-1 (see diagram):

1. Divide students into two groups. One group is the Water Droplets team. The other is the Sediments/Rock team.
2. Have the Sediments/Rock team line up across the middle of the room, not touching each other. Have the Water Droplets crawl from one end of the room to the other, passing between the Sediments/Rock team. (Optional: Time how long it takes for the Water Droplets team to get from one end of the room to the other.)
3. Next, tell the Sediments/Rock team that they should try to keep the Water Droplets team from getting across the room. (Optional: Time how long this takes.)
4. Switch teams and repeat.
5. Discussion Questions:
   a) How did the Sediments/Rock team try to keep the Water Droplets team from reaching the other side?
   b) Were they able to keep them from reaching the other side?
   c) (Optional [if timed]: How long did it take?)
   d) Did it take a long time?
   e) Why or why not?
   f) How does this compare to what really happens when water moves through the earth?

6) Pass around a closed jar that has sediment and rock in it. Ask students to look for small spaces between the sediment and rock that water droplets may be able to get through.

FOR GRADES 2-6 (See diagram; use only for groups of 8 or more people):

1. Divide the class into groups representing water droplets, gravel (loosely packed), clay (tight, hard for water droplets to get through), a large solid rock (impossible to go through unless the water finds a way around the rock formation, or a crack in it). More students should be in the clay group than in the gravel; even more should be in the rock group. Fewer sediment types may be used if there are not enough people.
2. Gravel students squat side by side without touching.
3. Behind the gravel group, clay students squat side by side, holding hands.
4. Behind the clay group, solid rock students squat with their arms around each other's waists. They may choose whether or not to put a "crack" in their formation by having two students in the group not touching.
5. Water droplets (not touching each other) must try to squeeze through these different sediment layers. Water droplets must crawl. No sediment types may grab water droplets with their hands, or trip them with their feet or legs.
6. On the word "Go!" water droplets start at one end of the

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room and try to make it through the various layers. (Optional: Time how long it takes for the water droplets to get through.)

7. Do a second round. (Optional: Time it again.)

8. Discussion Questions:

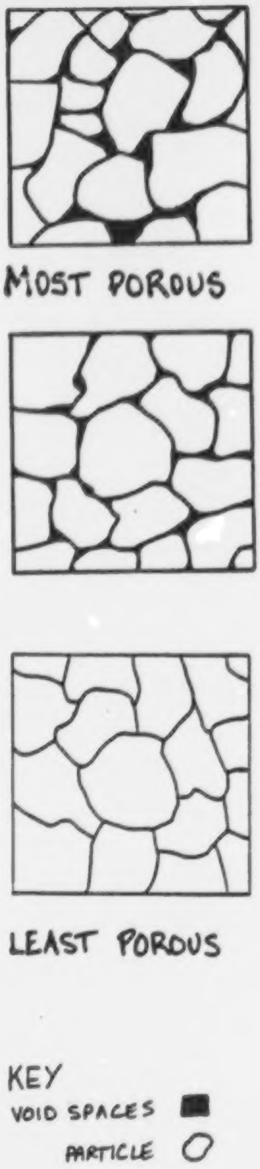
a) Did all the water droplets make it all the way through the layers?

b) What group was it easiest for the water droplets to get through? *(Gravel or rock)* Why? *(Gravel students were holding hands loosely, and squatting slightly spread apart. In a real situation, gravel is a collection of small rocks, with plenty of open spaces through which water can travel. Large rock formations act as barriers to water flowing underground. Water can flow through cracks in the rocks or go around the rock formations.)*

c) What group was the most difficult for the water droplets to travel through? *(Clay or rock. Clay particles pack very tightly together, and make it difficult for water to get through.)*

d) In what order do you find these layers under the ground? *(In any order. The layers under the ground may be any grouping of the substances represented in the game and others, like sand or humus.)*

9. Pass around containers of gravel and clay, and a rock. Tell students to look for the spaces between the pieces of gravel, particles of clay, or for cracks in the rock where water droplets might be able to get through.



BACKGROUND:

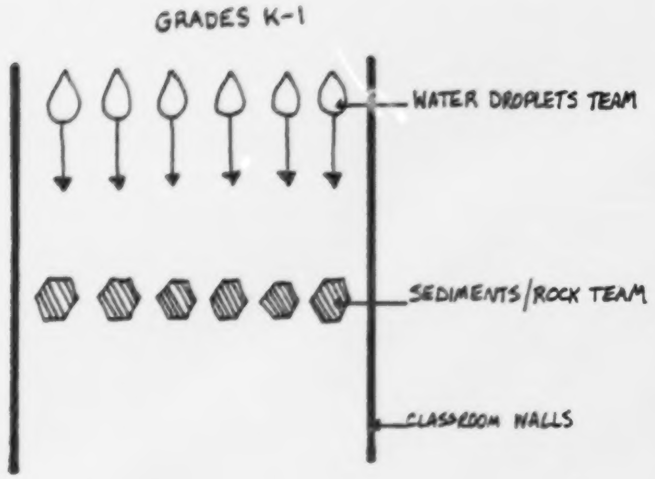
Sand, gravel, rocks and clay are four different types of earth materials. Whereas water can travel with relative ease around individual particles of sand and gravel, it is much more difficult for water to find its way around rocks or clay particles. In the case of rocks, water must find a crack or hole, dissolve the rock, or simply go around the entire rock. In the case of clay, the particles are tiny and close together, and pore spaces are not interconnected well, so water cannot easily find its way through it to soak further down into the earth.

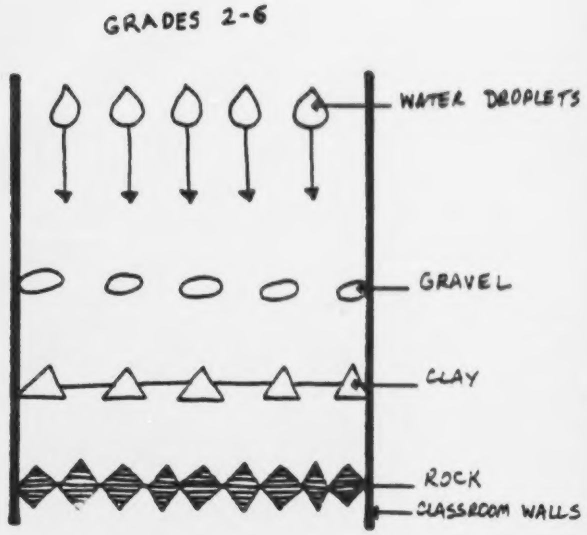
In Michigan, the ease with which water moves into the ground is dependent on the glacial geology of the region. Michigan has till, outwash and lake deposits. Till is a mixture of soil and rock, ranging in size from clay particles to boulder-sized rocks. In general, till will not allow water to easily pass through it, due to the presence of clay and the fact that particles of various sizes are packed tightly together. Outwash, primarily a mixture of sand and gravel, will allow water to flow through it easily. Lake deposits may be made up of clay, silt or sand, so the ease with which water may pass through is dependent on the particle types that are present.

The table on the next page shows the depths and yields of wells in various glacial aquifers.

GROUNDWATER AVAILABILITY IN GLACIAL AQUIFERS

GLACIAL AQUIFERS	WELL DEPTH (IN FEET)	YIELD (GAL/MIN)
Outwash deposits: sand & gravel, contains silt in places	25-200	1-1,000
Lake sand: sand, some gravel, and interbedded silt and clay	25-100	80-500
Till: intermixed clay, silt, sand, gravel and boulders; sand and gravel less abundant in some areas	25-200	5-200


GRADES K-1
WATER DROPLETS TEAM
SEDIMENTS/ROCK TEAM
CLASSROOM WALLS


GRADES 2-6
WATER DROPLETS
GRAVEL
CLAY
ROCK
CLASSROOM WALLS

SECTION 5

WHAT NATURAL FACTORS INFLUENCE WATER QUALITY?

Soil Solutions:

How does groundwater get contaminated? An experiment in dissolving

SUMMARY: Each small group of students has some mixture of soil, salt and/or koolaid in a funnel. Groups make a prediction about what will happen when water is poured through the funnel, then observe what occurs and describe the results.

OBJECTIVES: To demonstrate how things dissolve, and to explain that water can dissolve things as it moves underground.

VOCABULARY WORDS: dissolve, copper, iron, soil

TIME REQUIRED: 30 minutes

MATERIALS NEEDED:

1 Coffee filter or paper towel for each group of 3-5 students
1 Funnel for each group of 3-5 students (can be made by cutting the top off of plastic soda pop bottle, and turning the top piece upside down, or by poking a hole with a pencil in the bottom of a paper cup, and securing the filter or paper towel around the rim of the cup with a rubber band)
1 Cup or container (preferably clear plastic) for each group
1/2 Cup of salt
1 Packet grape or darkly-colored koolaid
About 6 cups of soil

PROCEDURE:

1. Each group of 3-5 students should be given materials for their demonstration: a paper towel or coffee filter, and a funnel. (The top of a plastic soda pop bottle with the bottom cut off, and turned over makes a good funnel.) In addition, group 1 is given powdered grape koolaid; group 2 powdered grape koolaid and soil; group 3 salt; group 4 salt and soil. If there are more groups, different combinations can be given out.

2. Explain to students that each group is going to do a demonstration for the class. They will set up a funnel containing a coffee filter or paper towel, resting in a clear cup or container (see diagram). Then they will put their substance(s) into the filter/funnel. Students then predict for the class what will happen when water is poured through their system.

3. Hand out one worksheet per group. Ask each group of students to write their predictions on a sheet of paper.

a) After being poured through the funnel, will the water look any different?

b) Will it taste any different?

c) Will it have any new substances in it? If so, what?

d) Will we be able to see the new substances? If not, how can we tell that they are there?

4. Give each group a few minutes to discuss their set-up and write their predictions down.

5. Hand out 3/4 cup of water to each group. Allow them to pour the water through the funnel set-up and write down their observations. One person in groups 1 and 3 may taste a tiny bit of their results. (If you plan to allow tasting, make sure funnels and cups are thoroughly cleaned before the experiment.)

6. Ask each group to share their prediction and observations with the class.

7. Put materials away.

8. Discussion Questions:

a) How did the koolaid get from the funnel into the cup? *(It was dissolved by the water.)*

b) Will it hurt you to drink water with koolaid dissolved in it? *(No! That's how koolaid is made.)*

c) How did the salt get from the funnel into the cup? *(It was dissolved by the water.)*

d) Water which comes from wells passes through sediment just like this. If there are things that can be dissolved which are located in that sediment, what happens to them? *(They may be dissolved by and into the well water.)*

e) There are some things that you can see that may be dissolved in the water at your house. Has anyone ever noticed orangish stains in the tub, sink, or toilet at your home? *(Those who have are seeing evidence of iron, which is dissolved in their drinking water from the ground. This is not harmful to drink.)*

f) Is there anyone who has seen greenish-blue stains in the tub, sink, or toilet at your home? *(Those who have are seeing evidence of copper, which has dissolved in their drinking water from the ground, or from their pipes. This is usually not harmful.)*

g) Under the ground, there is no koolaid. What things are on or underground, that might get dissolved into water when it runs under the ground? *(Salts, dead leaves, limestone, iron, copper)*

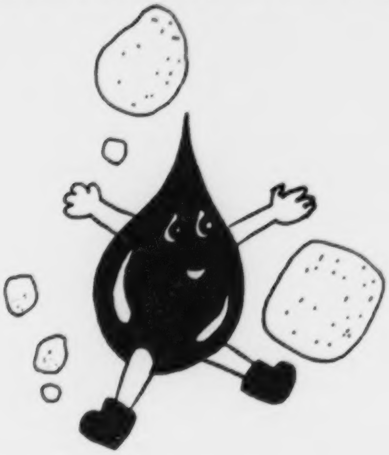
h) Are these things bad for you? *(No, not in normal concentrations.)*

i) If something that was bad for you was put in the ground, would it dissolve in water? *(Maybe)*

j) How would we take care of this problem? *(Clean up the pollutant, or drink water from a different place, either from under the ground, or above the ground.)*

EXTENSION:

1. Brainstorm a list of ways that water can become polluted.



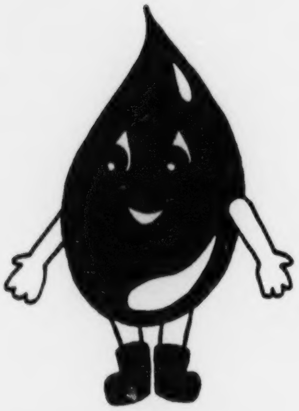
BACKGROUND:

Many substances are put into and onto the ground by people, such as salt scattered on roads and sidewalks to melt ice and snow, used motor oil that is dumped on the ground or down sewers, or containers that used to hold household cleaners being put in landfills. Most people are not aware that these substances can cause contamination of groundwater if they are dissolved into it.

In fact, the average household contains 3-10 gallons (11-38 liters) of materials that are hazardous to human health and/or the natural environment. The use of road salts, such as potassium chloride, sodium chloride and calcium chloride, have created significant groundwater contamination problems in the northern U.S., where approximately 10,000,000 tons of salt are used in the winter months. This salt can dissolve in run-off and percolate into soils adjacent to highways, thereby causing groundwater contamination.

Household septic systems are another source of groundwater contamination. When improperly maintained or installed, or used in the wrong types of soil conditions, they can contaminate groundwater with viruses, bacteria and microorganisms. Septic tank effluent may enter a well supplying a homeowner with water.

Trying Out Tastebuds:
When is water not drinkable?



SUMMARY: By adding salt to a cup of water and tasting it intermittently, students learn about concentrations of pollutants.

OBJECTIVES: To show how a normally harmless substance can occur in concentrations that make water undrinkable. To demonstrate how some substances are harmless at low levels, but harmful at increased concentrations. To discuss how water can be polluted and made undrinkable with either toxic or non-toxic substances.

VOCABULARY WORDS: pollute, toxic, non-toxic

TIME REQUIRED: 20 minutes

MATERIALS NEEDED:

1 Worksheet for every group of 3-5 students

1 Cup of water for every group (2 cups, if you also do the experiment with vinegar)

1 Small pile of salt for every group

1 Small button (1/2" diameter) for every group

1 Small cup of vinegar and a spoon for every group (optional)

PROCEDURE:

1. Explain that the class will be doing an experiment, and tasting "pollutants" that will not make them sick. However, other pollutants, which will not be used in this experiment, will make people sick if they taste them. Salt and/or vinegar will by used for this experiment. Both are used in small amounts for cooking and flavoring.

2. Give each student group of 3-5 a cup of plain drinking water, a small pile of salt, and a button. Have each group designate a "taster," a "secretary," and a "polluter." (If groups are larger than 3, additional students can take turns being the "polluter.")

3. Grade 1: Without letting the "taster" see, the "polluter" in the group adds as much salt as fits on one button to the glass and stirs. As each buttonful is added, the "secretary" draws a button inside the cup on the worksheet.

Grades 2 - 5: Without letting the "taster" see, the "polluter" adds 0 to 3 buttonfuls to the glass, and stirs. The secretary writes the number of buttonfuls added in the cup on the worksheet.

4. The "taster" tastes (emphasize that a taste is a small sip only!) between each addition.

5. The "polluter" keeps adding salt, buttonful by buttonful, until the "taster" declares it undrinkable. The "secretary" totals the number of buttonfuls at which the water became undrinkable, and writes it in the blank space on the worksheet.

6. Repeat with spoonfuls of vinegar in a second cup if desired. (White vinegar is like an invisible pollutant.)

7. Groups meet and compare the amounts they found to be unacceptable. Younger students should draw as many buttons as it took buttonfuls of salt for the water to become "undrinkable," and as many spoons as it took spoonfuls of vinegar for the water to become undrinkable. They can also write the number down (see worksheet).

8. Discussion questions:

a) Is salt bad for you? *(No. In small concentrations it is fine, but too much of it, like too much of many other things, can make you sick.)*

b) Have you ever eaten too much candy? How is that experience like drinking the very salty (or vinegary) cup of water? *(Candy is something that is all right in small amounts, but can make you sick in large amounts.)*

c) What if we had added something that is never all right to eat (such as gasoline, oil, paint, or a dirty diaper) to the glass of water? Would you want to taste it then? *(No. Even tiny amounts of these things could make you sick if you drank them.)*

d) Can water be polluted by things that are okay to eat? *(Yes, when these things are in the water in amounts greater than we are able to eat or drink without becoming sick.)*

e) Can water be polluted by things that are never okay to eat? *(Yes. Even a small amount of these things can make water so polluted that we cannot drink it without getting sick.)*

f) What would happen if a whole town were drinking polluted water? *(Many people in the town could get sick).*

EXTENSION:

1. Have each student draw one source of water pollution.
2. Draw a bar graph comparing the amounts at which different "tasters" found the water "undrinkable."

BACKGROUND:

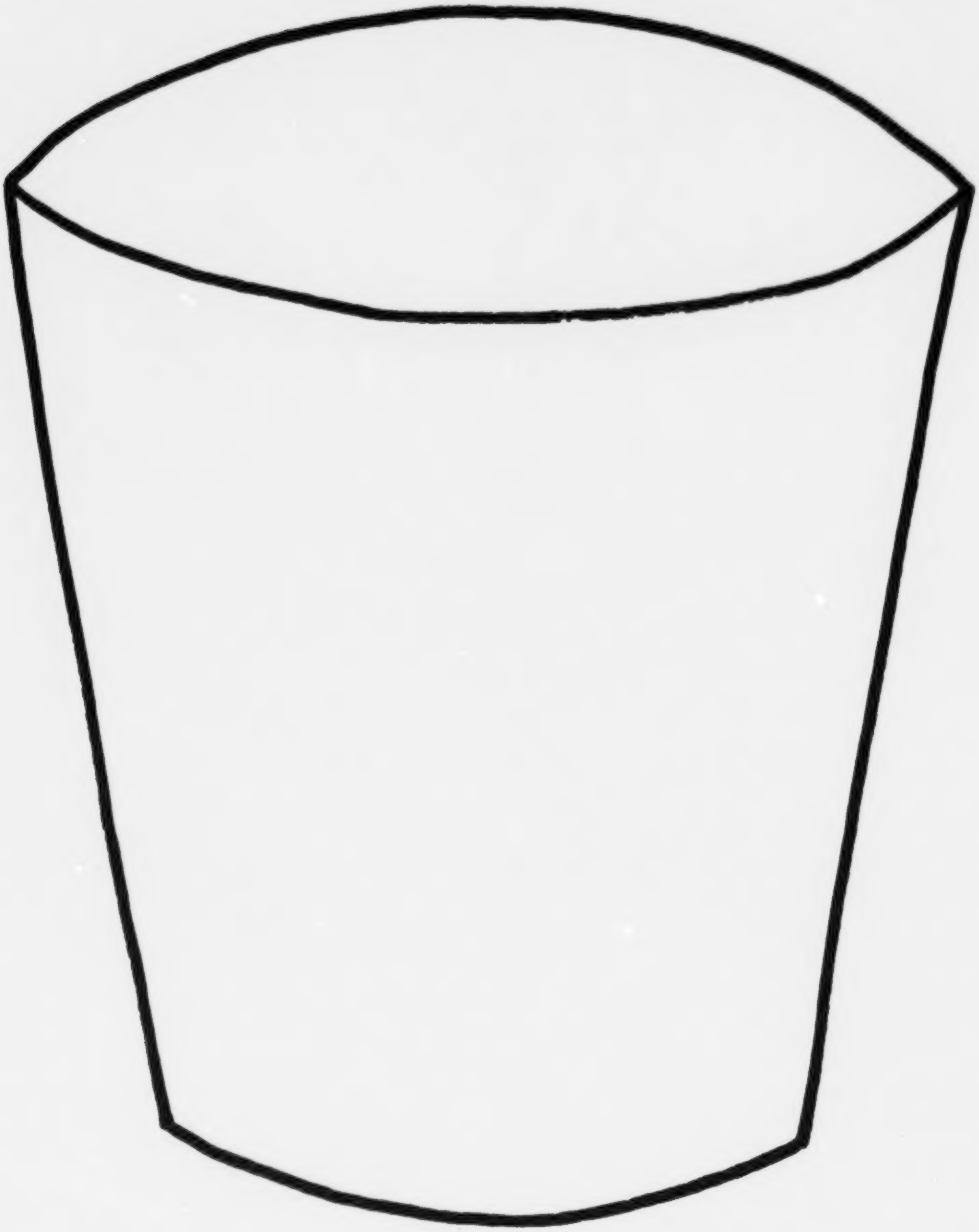
What is salt and how does it affect human health and groundwater quality? Salts are substances which dissolve in water. Different types of salt exist, and have different effects on groundwater and human and animal health.

Table salt (sodium chloride) is utilized by the human body in small amounts, but can become harmful in high concentrations.

Road salt can be the same substance as table salt, or a different chloride, such as potassium chloride or calcium chloride. All are used to melt snow and ice, and potassium chloride and calcium chloride are not usually used on food. But, like table salt, all chlorides used as road salt are easily dissolved by water. They can enter groundwater in dangerously high levels if large quantities of road salt, such as piles stored outdoors, are exposed to precipitation. When it rains, this salt can percolate through the soil into the groundwater. The Michigan Department of Natural Resources has identified 29 Michigan salt storage facilities that have caused groundwater contamination in this manner. At one site, the contamination plume was 350 feet (107 m) wide, 3,000 feet (915 m) long, and moving at a rate of 350 - 400 feet (107 - 122 m) per year.

There are other substances that naturally occur in water, and at common concentrations, they are not harmful to human health.

In this activity, students will experience how a normally harmless substance, such as table salt, can occur in concentrations that make water undrinkable. Since groundwater is the largest single supply of fresh water available for use by humans, we need to be concerned about the presence of excessively dissolved materials in it. Groundwater is a delicate resource—it is not considered desirable for drinking if the quantity of dissolved salts is in excess of 1,000 milligrams per liter. Too much salt in water is particularly dangerous for people with heart trouble, but is potentially harmful to anyone, since the human body is not used to such high quantities of certain substances and cannot process them.



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SECTION 6

HOW DO PEOPLE AFFECT GROUNDWATER?

The Human History of Water Town:

An almost-true tale in one act

SUMMARY: This is a story about who uses water in a community. As the teacher tells the story, students will be called to the front of the class and asked to demonstrate part of the story in a specific way. Afterwards, they will be asked to draw a part of the story. Older students calculate the specific volumes of water given, to develop math skills. Younger students can use relative terms, like "a lot" or "a little."

OBJECTIVES: To show that surface water or groundwater can be used to meet water demand, and that there is a greater quantity of groundwater than surface water. To demonstrate that different quantities of water are used for different activities. To show how water consumption increases with increased human activity as a town grows.

VOCABULARY WORDS:
company, groundwater, well, pump

TIME REQUIRED: 35 minutes

MATERIALS NEEDED:

5 Cups with water in them
1 Container (preferably clear) that can hold 5 cups of water
1 Container (preferably clear) that can hold 10 cups of water
1 Empty bucket that can hold 20 cups of water
Pitchers or empty pop bottles containing 15 cups or more of water
Drawing materials
5 Copies of the "Family" name tag and 1 copy of each other name tag
Masking tape
1 Measuring cup

PROCEDURE:

1. Read the following story aloud: "Once upon a time, there was a clearing in the woods with a creek running through it. Lots of plants grew by the creek, and got their water from it. Deer came there to drink, birds came there to take their baths, and fish swam in the creek." Ask a student to come up. Tape the "Plants and Animals" name tag to the student's chest. Give the student one cup of water. "This cup of water represents how much water the plants, deer, birds, and fish used each day." Student should stay in the front of the room, holding one cup of water.

2. "One day a family of people came to the creek. 'This looks like a great place to live!" they said. The family set up a camp and later built a house there. They took water from the creek every day to drink, bathe, and wash their clothes." Ask another student to come to the front of the class. Tape the "Family" name tag to her or his chest. Give the student one cup of water. "This cup of water represents the amount of water the family used every day for drinking, bathing, and washing." Student should stay in the front of the room, holding the cup of water.

3. "One day a farmer came to the houses around the little creek. She decided that she wanted to grow tomatoes in the field by the houses. She hauled bucketfuls of water from the creek to water her tomatoes every day." Ask a student to come up to the front of the class, and tape the "Farmer" name tag on her or his chest. In full view of the class, measure 5 cups of water and pour into a container. Have the students count with you as you pour the water into the container. Give the student the container with 5 cups of water in it. "This container of water represents how much water she needed to water her tomatoes every day in the summer." The student should stay in the front of the room, holding the container of water.

4. "More people heard about what a great place this was to live. A builder came and built a subdivision for four families there. Four families came and moved into the new buildings. They all used water for drinking, bathing, and washing things. The little creek did not have enough water in it for a farm and so many families, so each new family dug a deep hole into the ground. In the ground they found water, called groundwater. They attached pumps to suck the water up from the ground and into their houses. By building these wells, they were able to use groundwater in their houses." Have four students to come up to the front of the class and tape "Family" name tags to their chests. Give two students each one cup of water. "These cups of water represent how much groundwater their families used every day." Give two other students each two cups of water. "These families did not pay attention to how much water they used. They wasted water all the time." Students should stay in front of the room, holding their cups of water.

5. "Soon after the subdivision was built, a company that made paper came to the new town. The people in charge of the company built a big factory and began making paper for the people

of the town and for others. Many people in the town got new jobs working at the paper company." Ask a student to come up to the front of the class and tape the "Company" name tag to her or his chest. "To begin with, the company was using 20 cups of water every day! After a while, they couldn't get enough water from their wells to supply 20 cups a day. So they reused some of their wastewater, and cut back to 10 cups of water per day." Give the student a bucket, or other container with ten cups of water in it. "The company mixed pieces of wood with water to make paper." Student should stay in the front of the room holding the bucket, or setting it down in front of her or him.

6. "Now the town had many houses, a paper company, and a farm. Each of these used water from the ground or from the creek. There were still plants, deer, birds, and fish that used the water, too."

7. Discussion Questions:

a) Does everybody in our community use the same amount of water? *(No)*

b) Who uses the most water? *(Paper company: ten cups)*

c) Who uses the smallest amount of water? *(One family, or the plants, deer, birds, and fish: one cup)*

d) Who uses more water, a farmer or one household? *(The farmer. The farmer uses 5 cups, and one household uses one cup.)*

e) Who uses less water, the paper company or one household? *(One household. The paper company uses 10 cups, and one household only uses 1 or 2 cups.)*

f) If ten more houses were built by the creek, would all the households together use more water than the farmer? *(Yes. 1 or 2 cups x 10, or 1 or 2 cups added ten times, equals more than the 5 cups that the farmer uses.)* Would they use more water than the paper company? *(The same amount or more. One cup x 10, or one cup added ten times, equals 10 cups, the same amount used by the paper company. Two cups x 10, or 2 added ten times equals 20 cups, more than that used by the paper company.)*

g) How much water was used every day? *(1 cup for plants and animals + 6 cups for four households + 5 cups for the farmer + 10 cups for the paper company = 22 cups per day.)* Have all the students pour their water into one big bucket or other container, and take their seats.

h) Set one cup of water next to the container holding all the water. "This cup is the amount of water used by the plants, deer, birds and fish, before people came to live by the creek. The bucketful is the amount of water used by the whole town after people built houses and a company, and started a farm. When is less water used—when there are only animals and plants living in a place, or when there are people living and working there, too? *(When there are plants and animals alone. There was 1 cup used by plants and animals alone, 22 cups by the end of the activity.)*

i) What happens when more people, farms, and companies move into a town? *(More water is needed.)*

j) Where did they get the water they needed when there wasn't enough water in the creek anymore? *(From a hole they dug in the ground.)*

k) How much water do typical household activities use? *(Share any of the following statistics that you feel relevant.)*

HOUSEHOLD USE

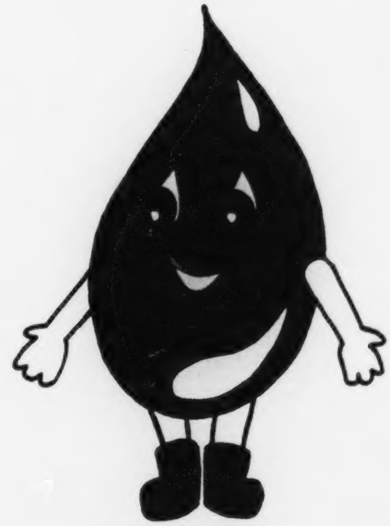
Shower: 5-10 gallons per minute (80-160 cups)
Full Bath: 50 gallons (8,000 cups)
Toilet Flushing: 5-7 gallons (80-112 cups)
Dripping Faucet: 1,000+ gallons per year (16,000+ cups)
Dishwasher: 15-20 gallons (240-320 cups)
Washing machine: 35 gallons (560 cups)
Lawn Watering per 1/2 acre: 35 gallons (560 cups)

EXTENSIONS:

1. Develop the story into a play, with characters, actions, and costumes. Perform the play for another class.

2. Create a bar graph of the amounts of water used by the different characters in the story.

3. Have students draw their own picture of a house, farm, plant, deer, bird, or fish in our town. Each picture should show water being used in some way by the household, company, farmer, plant, or animal. Put all the students' pictures together on a wall bulletin board. Choose a name for the town, and make a sign with the name on it for the display.



BACKGROUND:

How much fresh water do humans use? To answer that question we should first make a distinction between "use" and "consumption." Often water is withdrawn from a source (either groundwater or surface water), used for something like cooling machinery, and then returned to the source. This is called water use. Other times, processes may render the water unavailable for reuse. These are called consumptive uses and include industrial processes (like manufacturing), irrigation, and public water supply. Given this, let's change the question to how much water is consumed and where does this water come from?

On average, the human body requires about 2.5 quarts (about 2.4 liters) of water per day. But we use a lot more water than is needed internally. For instance, some estimates put the level of use at about 240 gallons (908 liters) of water per day for an American family.

In Michigan, we use about 11.6 billion gallons (44 billion liters) of water per day, 645 million gallons (2,441 million liters) of which are actually consumed. This amount can be broken down a little further:

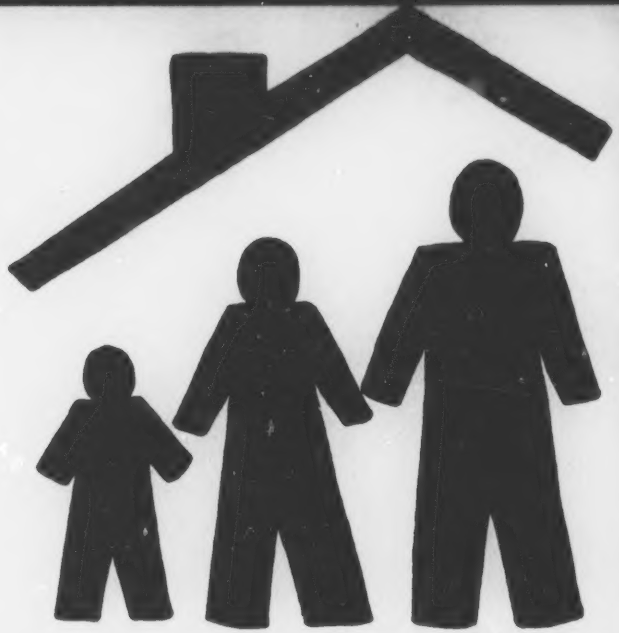
Δ Municipalities use more than one billion gallons of water per day, about 80% of which comes from groundwater.

Δ Irrigation uses 77.5 billion gallons of water per year (as of 1977), 37% from groundwater. (Experts estimate that 90% of the water withdrawn for irrigation is lost to evapotranspiration.)

Δ Industries use about 900 billion gallons of water per year; probably less than 10% of that comes from groundwater.

Overall, about 5% of the water withdrawn is consumed, and the consumed portion is divided up as follows: irrigation 38%; industrial self-supply 22%; public supply 21%; and thermoelectric power generation 19%.

Family



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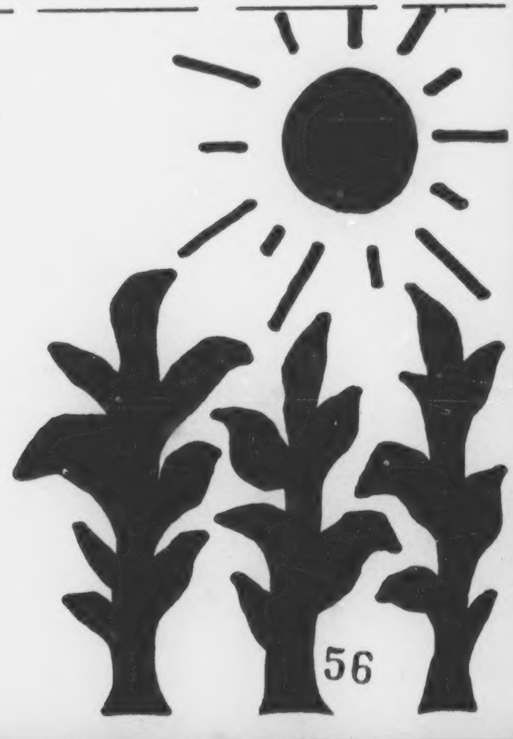
Farmer



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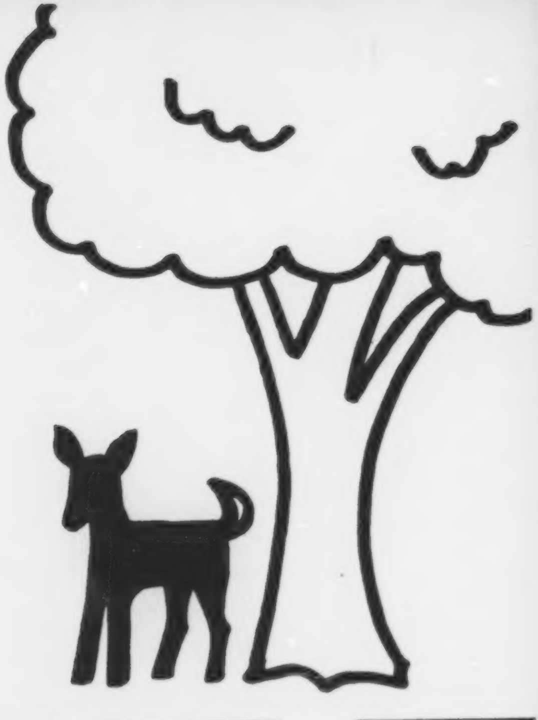
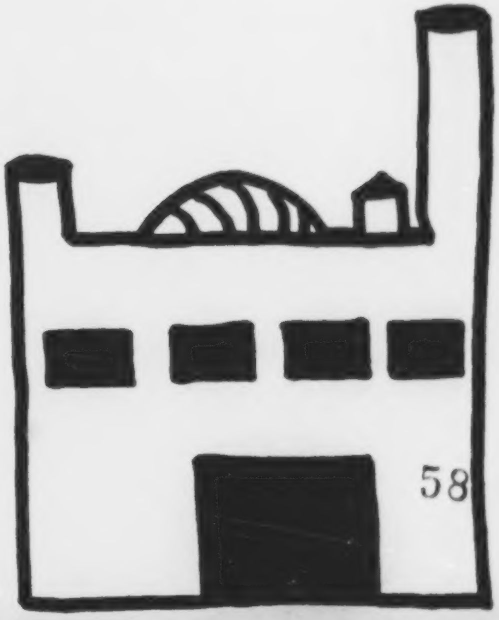
Plants & Animals



Company



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What's in a Puddle?

Observe puddles and how they form

SUMMARY: Students go outdoors on school grounds and predict where puddles will form, and learn about run-off and how different surfaces affect water quality.

OBJECTIVE: To learn what happens to water when it rains on earth versus pavement.

VOCABULARY WORDS: paved, run-off

TIME REQUIRED: 15 minutes before a rain and 30 minutes after a rain

MATERIALS NEEDED:

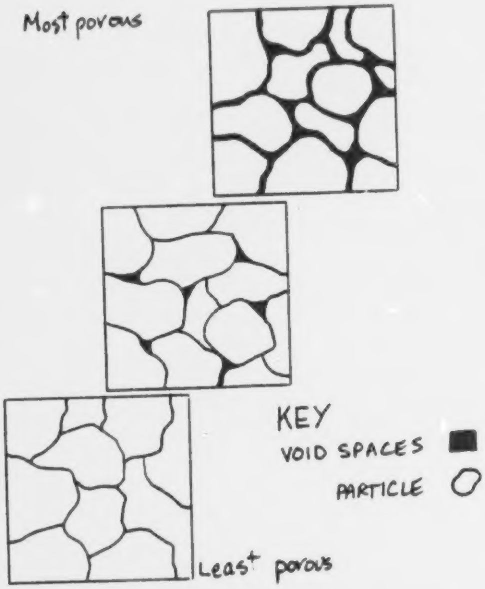
A nearby paved surface and grassy area right before and soon after a rain or thaw

Chalk

Writing materials

Drawing materials (optional)

Storybook about puddles (optional)



PROCEDURE:

1. During a dry period (if possible, right before a rain) take students outdoors to the schoolyard. Divide them into groups of 3-5. Have groups predict where puddles will form when it rains. In paved areas, have them draw chalk outlines where they predict puddles will form.

2. After a rain, see if puddles formed where predicted.

3. Observe a puddle on the paved parking lot or driveway. Is there a shiny oil slick or other colors in the parking lot puddle?

4. Observe what's in a puddle that forms on soft ground or grass.

5. Discussion Questions:

a) What happens to rain that falls on the driveway or parking lot? *(It flows downhill into lower places and forms puddles, or it goes into the gutter.)*

b) Why isn't the water in the parking lot puddle clean? *(As the rain flows across the pavement, it picks up pollutants.)*

c) What is in the parking lot puddle? *(Run-off from pavement often includes car products like motor oil, antifreeze, particles from car exhaust, and dirt. If there is a lot of dirt in it, it may be a mud puddle that also has these other things in it.)* Tell the students not to touch the puddle. The teacher can dip a piece of paper in it to see the residues better.

d) Why are there permanent ponds built near many parking lots and areas where a lot of new houses, apartments, or buildings have been built? *(Because all that pavement doesn't allow water to soak in so it runs off. To give such water a place to "go," these types of ponds are built.)*

e) What happens to rain when it falls on the grass? *(It soaks into the ground, or forms puddles in low places. If the low place is not grassy, but bare dirt, a mud puddle may form.)*

f) Which puddle has cleaner water in it? *(Probably the puddle in the grass.)*

g) Which kind of area may keep water cleaner: areas of plants and grass, or paved places like driveways, roads, and parking lots? Why? *(Areas of plants and grass, because they are less likely to contain pollutants that can get into the water.)*

6. Write a story about the formation of a puddle. Where did the water in the puddle come from? How did it get into the puddle? Was anything besides water in the puddle? What does the puddle look like?

EXTENSIONS:

1. Have each student draw a picture of a puddle.

2. Read a story or poem about puddles to the class. ("Just Spring," by e.e. cummings, is one puddle poem.)

BACKGROUND:

Several factors influence the rate and amount of water that is absorbed in the soil. One of these factors is rainfall. The intensity of a storm, vegetation present, and the duration of rainfall, can all have an effect on the infiltration of water in the soil.

If rain reaches the soil surface faster than it can be absorbed through the pores in the soil, the water pools on the surface, forming a puddle. Some surfaces, such as driveways and paved parking lots, allow the water to flow over the surface, picking up pollutants as it moves. This water, called run-off, eventually finds its way to rivers, lakes, streams, or groundwater.

In areas used by cars, oil, gasoline, and antifreeze can collect on impermeable surfaces such as asphalt. They then can be washed into puddles or settling ponds, or into storm drains leading to the local river.

The Polluted Groundwater Story:

A graphic tale of how groundwater gets contaminated

SUMMARY: A cardboard "water droplet" is buried in gravel or sand, and is pulled out every time a new "pollutant" enters the water around it. This is told in story form, as the pollution in the gravel or sand gets worse and worse.

OBJECTIVE: To demonstrate how tiny bits of pollutants add up to cause a big pollution problem in groundwater.

VOCABULARY WORDS: fertilizer, pollutant, groundwater, salt, household chemicals, motor oil, solid waste, hazardous waste, leaching, toxic, solid waste, landfill

TIME REQUIRED: 15 minutes

MATERIALS NEEDED:

A clear wide-necked jar, fish bowl, or plastic soda pop bottle with the top cut off
Water
White aquarium gravel or lightly colored sand
1/2 Cup of soil from the school grounds
Several types of "pollutants" in unmarked containers: salt, oil, food coloring, baking soda*, vinegar*, a paper towel soaked in food coloring
A water drop shape cut out of lightly colored corrugated cardboard, and tied to a piece of wire (or string). Draw a sad face on the water drop.

**Vinegar and baking soda are actually both very safe household cleaners. Do not reveal their true identities, but identify them as representing commercial fertilizers and strong household cleaners. They are used here because, when combined, they will cause a dramatic fizzing reaction! They should be added at the same time. You will need at least 1 Tablespoon of each to make a visible reaction take place.*

PROCEDURE:

1. Put at least 5" of white aquarium gravel into the container. Sprinkle the schoolyard soil over the sand, and mix them together a bit. Explain to students that groundwater exists between soil particles. Soil does not usually pollute groundwater, even though it may look dirty.

2. Pour water slowly over the gravel in the container until the sand is just slightly less than saturated with water.

3. Tell the story of a drop of water that falls from the sky, falls on a tree, drips down from the leaves, falls on the ground and slowly seeps down into the ground.

4. At this point, put the cardboard water drop under the gravel near the edge of the container closest to the students. Tell the class that the water drop moves through the ground as groundwater. Review with the class the fact that groundwater is water that seeps into the ground, and moves slowly through pores and spaces between rocks, sand, gravel, or clay. Along our water drop's journey under the ground, it encounters some pollutants.

5. Have students come up one at a time and drop various substances into the front side of the container to demonstrate how different substances contaminate groundwater. Make sure that they add the pollutants at the very front of the container so that the other students will be able to see the pollutant as it seeps down into the gravel. Pour a small amount of "rain" over the pollutant. After each pollutant is added, pull up the water drop by the string or wire and ask, "How dirty is the water now?" Then bury the water drop again before the next pollutant is added. Add "rain" after each pollutant is added. The pollutants that should be added are:

a) baking soda* representing more dangerous household chemicals such as detergents, lye, oven cleaner, etc. (can get into the groundwater when they are poured down the drain or thrown into a solid waste landfill);

b) vinegar* representing commercial fertilizer (gets into the groundwater by heavy use on farms and lawns.);

c) food coloring representing hazardous materials or toxic materials (get into the groundwater when dumped by industries);

d) salt (gets into groundwater when it is used by road crews to melt snow on roads in the winter, or when it is stored on the ground before use);

e) cooking oil representing motor oil (gets into groundwater when rainwater runs off roads and parking lots, when an above- or below-ground container leaks, from discarded containers in a solid waste landfill, and from individuals and garages that dump their used motor oil illegally on the ground);

f) a paper towel soaked in food coloring representing garbage shows how contaminants can move with water from solid waste into the groundwater (this is called "leaching" and occurs at solid waste and hazardous waste landfills). Be sure to stick this on the edge of the container, and use a different color food coloring than step "c."

6. Discussion Questions:

a) If we pulled the water out of the gravel and soil here, what could we use it for? *(Not much!)* Could we drink it? *(No)* Wash with it? *(No)* Water our plants or crops with it? *(No)* If this groundwater eventually flowed into a stream or lake, could fish or ducks live in it? *(No)*

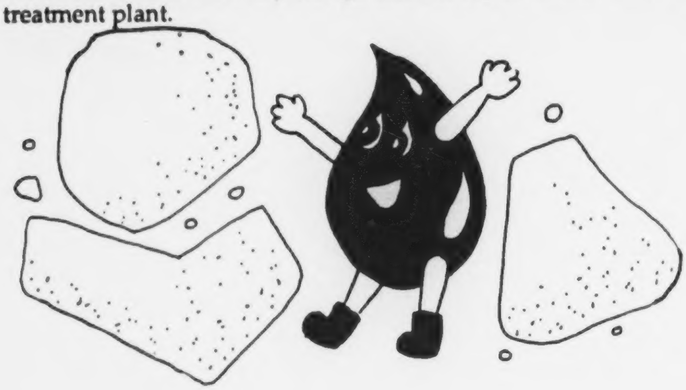
b) Was the water dirtier after adding many pollutants, or just one? *(After adding many.)*

c) How is our little water drop? *(Probably dirty, after being dipped into all the pollutants.)*

d) Which of these pollutants have you seen before? *(Road salt, oil, fertilizer, household chemicals, hazardous wastes, etc.)*

e) How can you, as individuals, help keep these kinds of pollutants from getting onto or into the ground, and into our groundwater? *1) Ask your family to use sand instead of salt on the steps and sidewalk in front of your house; sand will also melt ice and snow. Ask the town or city and your school to do the same. 2) Make sure your family does not overfertilize the lawn or crops if you have a yard or live on a farm. 3) Tell your family that it is better to recycle used motor oil than to throw it away because of its effects on groundwater — do not dump it on the ground or in a gutter. 4) Try to have your family buy more environmentally safe household cleaners, and suggest that the family take its dangerous household chemicals to a special household hazardous waste dropoff day. 5) Stay aware of groundwater issues by listening to the news, and tell others what you have learned.* Can you think of other actions that you could take to help protect groundwater from pollution?

7. Rinse out the gravel, to be used again for another activity. All the "pollutants" we used are non-toxic, and can be rinsed down the drain. From there they will go into the septic tank or wastewater treatment plant.



EXTENSION:

1. Have students each draw an ideal, unpolluted environment, making sure to include groundwater in their drawings.

BACKGROUND:

Each of us in our everyday activities can have a profound effect on the quality of groundwater. Common household chemicals which may be hazardous materials (used motor oil, municipal and industrial wastes, chemical fertilizers, pesticides, and herbicides), as well as sewer leakage and faulty septic tank operation, can all contribute to groundwater degradation. In many places in this country, groundwater is already contaminated.

Michigan is not immune to this problem. In a recent survey, over 1,500 sites of environmental contamination were identified in Michigan, almost all involving groundwater. In 1987, over 500 households in Michigan were restricted to bottled water for drinking, and at one time, 27-30 of the wells serving Battle Creek were contaminated.

Once polluted, groundwater is difficult, if not impossible, to clean. There are no natural microorganisms to break down most pollutants, and groundwater moves too slowly to permit any significant dilution and dispersal of contaminants. In Britain, an aquifer polluted with whale oil in 1815 still contained significant toxic residues in 1950!

The slow movement of groundwater does not bode well in terms of future groundwater pollution. Experts fear that many of the chemicals sprayed or dumped on the land two or more decades ago have yet to reach underlying groundwater.

Trash Over Time:

What happens in a landfill?

Adapted with permission from: "Making A Mini-Landfill," Recycling Study Guide, *Wisconsin Department of Natural Resources, 1989*

SUMMARY: In Part I, students will begin to see that they can make a difference in deciding how much waste they produce, and which wastes can be disposed of in a way other than by landfilling. Our wastes can be divided into a few basic categories. In Part II, students will actually create their own mini-landfills with trash from each of the categories above.

OBJECTIVES: To have students examine the materials that make up the products they use, and observe what happens to waste items when placed in a landfill. They will also decide whether the items should be disposed of in a different way.

VOCABULARY WORDS: landfill, dispose, compost, recycle, natural resources, energy, reuse

TIME REQUIRED: 30 minutes initially; 10 minutes/week for three following weeks; 20 minutes for final session.

MATERIALS NEEDED:

1 Worksheet for each student
5 Large clear glass jars
Soil
Small items from trash that fit each of 5 categories: reusable; compostable; recyclable/from a resource that will build back up over a fairly short period of time; recyclable/from a resource that will not build back up over a fairly short period of time; hard to reuse, compost, or recycle
Masking tape

PROCEDURE:

PART I:

1. Have each student think of one item he or she threw away today. What was the item made of? Into which of the following category of solid waste did the item fit?
    - a) reusable (ex. old clothes)
    - b) compostable (ex. potato peels)
    - c) recyclable/from a resource that will build back up over a fairly short period of time (ex. newspaper)
    - d) recyclable/from a resource that will not build back up over a fairly short period of time (ex. aluminum can)
    - e) hard to reuse, compost, or recycle (ex. plastic toothpaste tube)
2. Ask students what they think happens to the item when they throw it away.
3. Discussion Questions:
    - a) Where is away? *(There is no away! Everything that we throw away ends up somewhere!)*
    - b) What is a landfill? *(A landfill is where wastes are dumped. It can be as simple as a hole in the ground, or it may have a system of clay and plastic liners, monitoring wells to test for groundwater contamination, and a layering system of sediment and trash.)*
    - c) Explain some of the problems with landfilling trash *(It is expensive, it is a waste of natural resources and energy, it may contaminate groundwater, etc.)*
4. Ask students to name ways that they can avoid disposing of their trash items in a landfill. Discuss their answers and list responses on the blackboard.
5. Ask students if they want to save trees and other natural resources and produce less trash. If so, ask them from which category or categories they will try to buy more products, and which category or categories they will try to avoid.

PART II:

1. Write each of the 5 categories above (a, b, c, d, and e) on a separate piece of masking tape and put each piece of tape on a separate glass jar.
2. Fill each jar about half full with soil.
3. Put a sample of waste from each category into the appropriate jar, cover the sample with soil and keep it damp. Leave the lid off and place the jar on a shelf or table away from people and out of direct sunlight. Stir occasionally.
4. Have each student write down their prediction of what will happen to the item in each mini-landfill on the worksheet. Observe the items in the jars once a week over the next three weeks. List on the blackboard any changes that the students see.
5. Discussion Questions:
    - a) What happened to items in jar a?
    - b) What happened to the items in jars b and c?

c) What happened to the items in jars d and e?

d) How are the mini-landfills you made like real landfills? *(Both the mini-landfills and real landfills are places where items sit for long periods of time, usually covered with soil. Like our jars, landfills are a place where all kinds of things end up, including those which are: reusable; compostable; recyclable/from a resource that will build back up over a fairly short period of time; recyclable/from a resource that will not build back up over a fairly short period of time; hard to reuse or recycle.)*

e) How did what happened compare with the students' predictions? Have students write down their observations of each jar's contents next to their original predictions.

6. When the activity is completed, take the materials out of the soil and dispose of them in the proper manner, if possible *(compost, reuse, recycle, etc., and if you must, put an item in the trash can to be landfilled).* The soil should be dumped out in an area with more soil in or near the schoolyard with the teacher's supervision. The jars should be washed out and reused.

EXTENSIONS:

1. Make a class resolution to use both sides of pieces of paper and to recycle whenever possible.

2. Have a "Class Swap." Pick a day and, with permission from parents, ask each student to bring in an item that is reusable, but that they no longer want. Instead of throwing it into the trash, they can trade items at the "Class Swap."

BACKGROUND:

Every day, each one of us in the United States generates nearly 4 pounds of trash. Much of this waste ends up in landfills, where some of it, such as paper products, may degrade, while some of it, such as plastics, may stay intact well beyond our lifetime. Recent studies have shown that since garbage in a landfill is compacted so tightly, with no air circulation or light, even paper has difficulty biodegrading.

Much of the waste we generate need not be landfilled. Nearly 50% of the waste stream is composed of recyclable material, and composting can divert 8-18% of an average community's waste from landfills. By reusing objects before throwing them away, composting, and recycling, everyone can significantly decrease the amount of waste sent to landfills.

EXAMPLES OF ITEMS IN CATEGORIES:

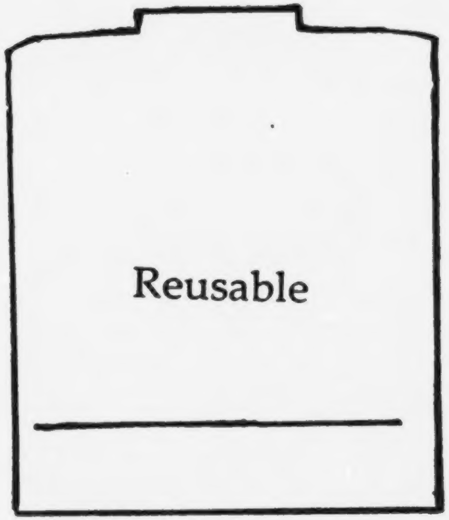
REUSABLE
Old clothes
Jars
Plastic and paper bags
Plastic containers
Boxes
Old furniture
Used appliances
Magazines
Plastic silverware
Egg cartons
Broken toys (can be fixed)
Odds and ends (for craft projects)
Scrap lumber
Cloth scraps (for rags)
This list can grow and grow...be creative!

COMPOSTABLE
All food waste except meat, fat, citrus rinds
Newspaper

RECYCLABLE/FROM A RESOURCE THAT WILL BUILD BACK UP
Newspaper
Cardboard
Magazines and catalogues
Brown paper bags
Office paper
Colored paper
Computer printout paper
File folders
What is recyclable in your area varies with the recycling program in your community

RECYCLABLE/FROM A RESOURCE WHICH WILL NOT BUILD BACK UP
Used motor oil
Aluminum (made from bauxite ore mined out of the ground)
Metal cans (made from various minerals mined our of the ground)
Glass (made from sand which is mined from sand dunes and deposits)
Copper (made from copper mined out of the ground)
Plastic (made from oil)
Car and household batteries (made from several mined metals)
Appliances that cannot be repaired (made from several materials)
What is recyclable in your area varies with the recycling program in your community.

HARD TO REUSE, COMPOST, OR RECYCLE
Toothpaste tubes
Plastic packing materials
Paper napkins and paper towels
Dental floss
Cat litter
See if your students can think of others, or if they can figure out safe ways these can be reused!



Predict ______________________

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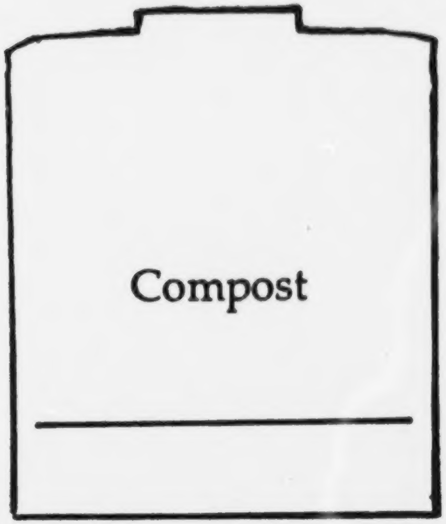

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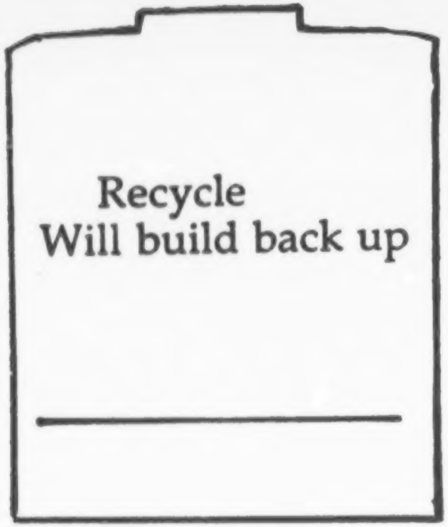
Recycle
Will build back up

Predict ____________________

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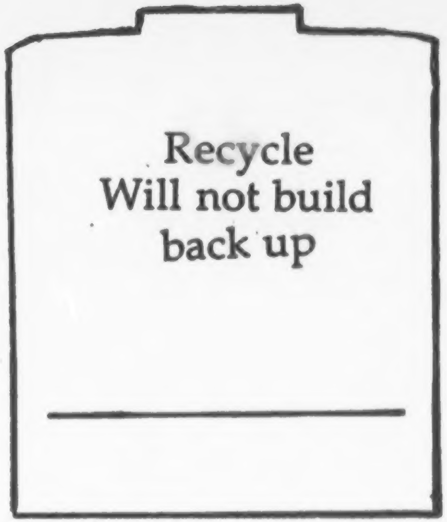
Recycle
Will not build back up

Predict ____________________

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Observe ____________________

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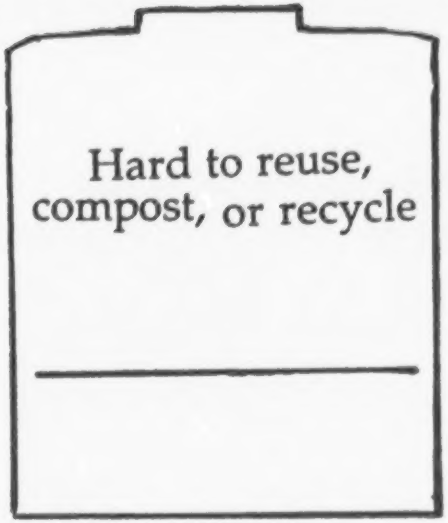
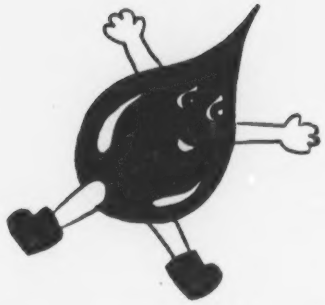

Hard to reuse, compost, or recycle

Predict

Observe

Gooey Garbage in the Ground:

How to build a landfill



SUMMARY: By putting a collection of lunch waste and other garbage in a container with water and letting it sit for two days, students observe how the water becomes undesirable. This simulates a landfill contaminating groundwater by leaching. Leaching is when water passes through a substance, and carries some of that substance away with it.

OBJECTIVES: To show how garbage in landfills can contaminate water. To show how non-toxic materials can make water undrinkable.

VOCABULARY WORDS: landfill, liner, toxic, leaching

TIME REQUIRED: 20 minutes; 10 minutes follow-up 2 days later

MATERIALS NEEDED:

1 empty 2-liter plastic soda pop bottle with cap or gallon milk jug with cap for each group of 3-5 students

Clay

Paper trash

Food waste from lunch

3/4 Cup water for each group of 3-5 students

4 Cups of soil from schoolyard

List of materials banned from your local landfill, and how such a list was determined (optional)

Sci/SS Lab

PROCEDURE:

1. If you need to, get permission from the lunch supervisor or principal for this activity.

2. Give each group of 3-5 students the top 3/4 of a plastic soda pop bottle or milk jug that has had the other 1/4 cut off the bottom (about 3" is to be cut off bottom). The cap should remain tightly screwed on.

3. Have 1-2 student groups press a thin layer of clay into their upside-down portion of bottle. Have 1-2 student groups do the same, but poke holes in the layer with a pencil. Have 1-2 groups not put any clay into their mini-landfill.

4. Each student group should do the following (see diagram):

a) Collect their lunch garbage and place in the container after lunch. Include small pieces of paper trash and food garbage.

b) Sprinkle a layer of soil from the schoolyard over the food waste.

c) Sprinkle 3/4 cup of water, or "rain" over the mini-landfill.

d) Set in a jar or cup (to hold level), spout side down. Let the wet mini-landfills sit for 2 days. Store them somewhere where the smell will not be bothersome. Do not put them outdoors if they are likely to freeze and remain frozen.

e) After 2 days, bring the mini-landfills back into the classroom. Sprinkle again with 3/4 cup of water

f) Place a clear jar or container below the spout in the bottle top and unscrew the cap. Let the water drain into your container.

5. Discussion Questions:

a) Is this water that the students would like to drink? *(No! It will be discolored and smelly at this point.)*

b) A landfill (students may commonly, but incorrectly, refer to it as a "dump") is like the soda pop bottle—a container (clay and/or plastic liner) with solid waste (lunch garbage) in it, with dirt (schoolyard soil) covering the waste, and with rain (water from the watering can) falling on it.

c) Where is your community's landfill? Who has been there? Can they describe what it looks like? (Show the diagram of a landfill.)

d) What happens to rainwater if a landfill's clay or plastic liner does not leak? *(Some of the rainwater collects within the garbage, on top of the liner. Because of this, water does not travel into the ground under the landfill.)*

e) What happens to rainwater if the clay or plastic liner does leak? Where does the dirty water go? *(It goes into the ground, often following the path of water that's already in the ground. If people nearby have wells, they may draw this water up to drink.)*

f) What happens to things in the landfill other than food, such as paint, motor oil, household chemicals? *(They all sit in the landfill. Some of them are liquids and leak. Others, too, are carried by the water that goes past them.)*

g) What happens if there are toxic substances in the landfill? *(They, too, can be carried down by the water that goes through the waste. If the liner leaks, they, too, can be carried into groundwater under the landfill.)*

h) Are there some things that should not be put in a landfill? *(Brainstorm a list of things that can pollute the water under the landfill, or other ideas. A list might include household hazardous wastes such as strong cleaners, drain openers, paints, old pesticides and fertilizers from their farm or yard, industrial hazardous wastes, used motor oil, etc.)*

EXTENSION:

1. Call your city or township solid waste department, or the agency responsible for local solid waste. Find out where the materials are taken, and ask if there is a list of materials banned from entering the landfill. Find out how this policy was decided, and by whom. You may find that there are different types of landfills available to your city or township. Different restrictions exist for municipal solid waste landfills, hazardous waste landfills, and "low-risk waste" (construction waste) landfills. With the class, compare the list of banned substances with the list they have come up with.

a. Discussion Questions:

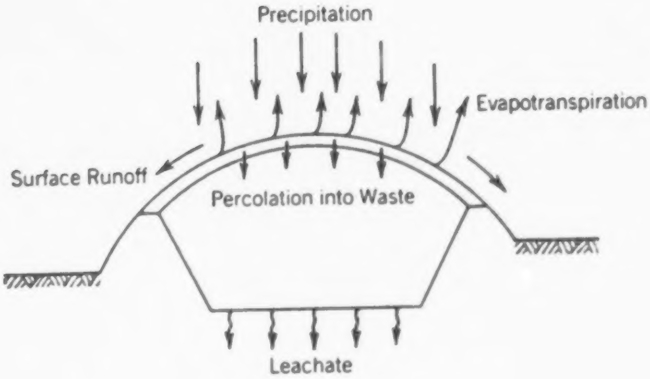
1) What materials appear on both the class' list and the landfill's list?

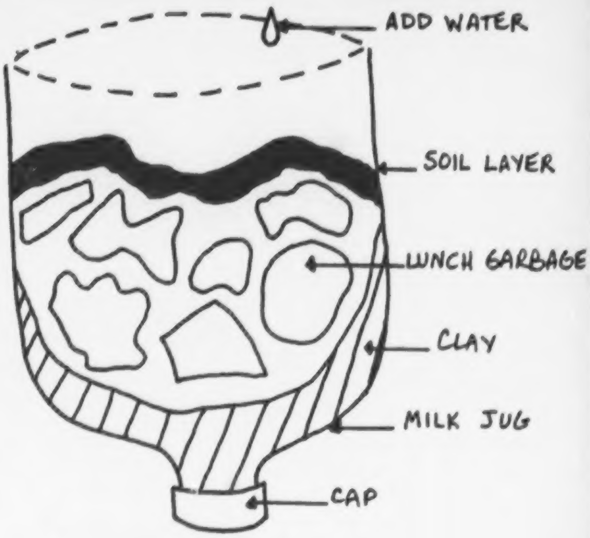
2) What materials are not on both lists?

3) Should some of the materials on the class' list be added to the landfill's list? Why?

4) Explain how the landfill list was decided upon. How did the class decide on their list? *(They decided through group discussion after gathering information from an experiment.)*

5) Was the way the class decided upon the list similar or different than the way the landfill's list was decided upon?





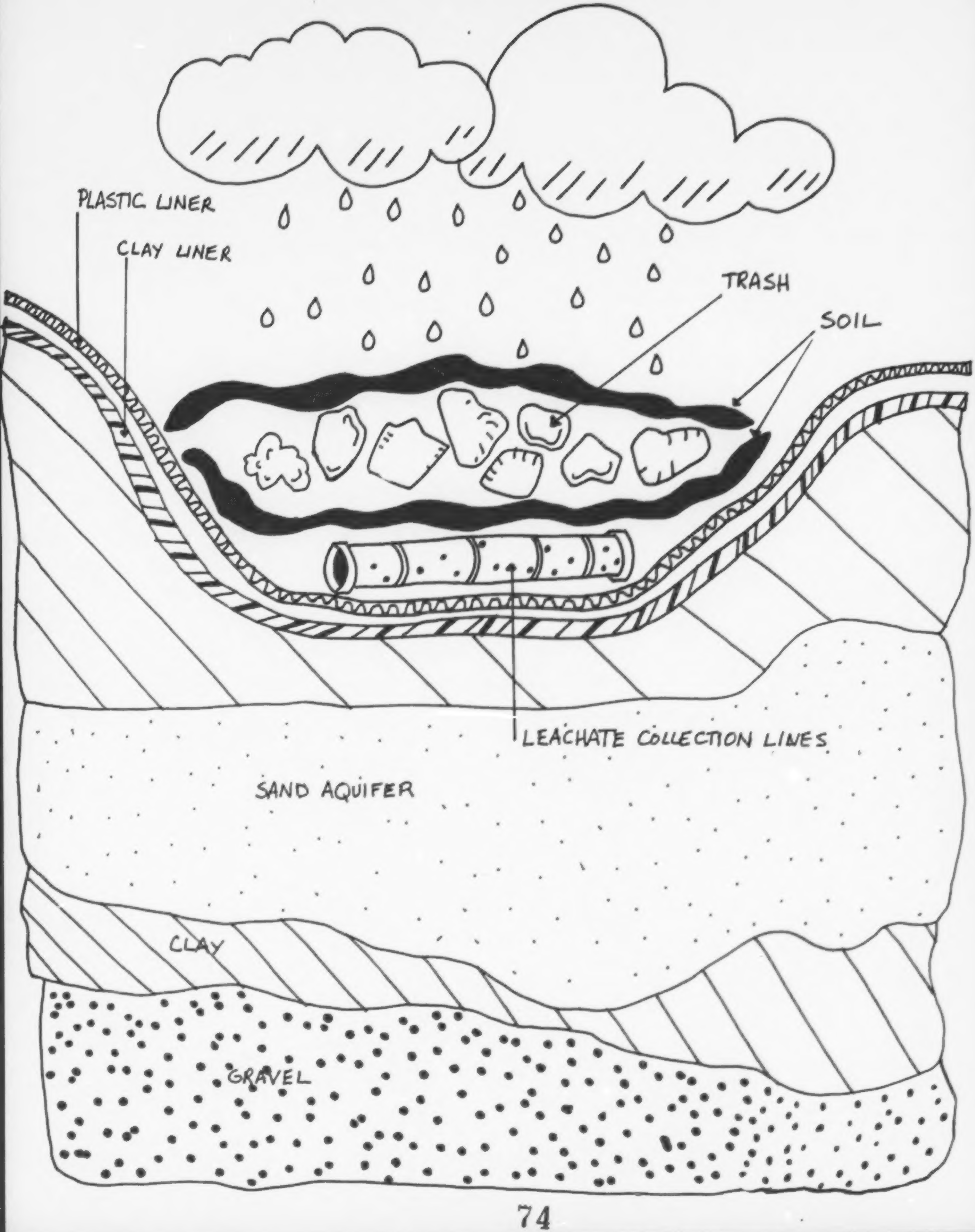
BACKGROUND:

Many people have the attitude that once they have taken their trash to the curb, dumpster, or dump, they no longer need be concerned with it. Naturally, most people don't spend their time thinking or worrying about what's happening to their garbage! In fact, this is something that we *should* be concerned about, because the garbage that we send to landfills can have a profound effect on the quality of groundwater.

Landfills constructed since the Resource Conservation and Recovery Act (RCRA) was passed in 1976 must follow certain rules of operation. The landfill site must be lined with clay and plastic, and a leachate collection system must be in place. Waste must be compacted and covered with dirt regularly. Previous to this and subsequent regulations, waste was often simply dumped in an open pit or a pile, with no requirement for environmentally sound practices.

Although landfills are now designed with groundwater protection in mind, using plastic and clay liners, recent studies have found that eventually, any liner will leak. When it rains, water percolates through the waste in a landfill, much as it does in the soil, picking up polluting chemicals as it travels. This liquid, called leachate, can leak from the landfill into the groundwater, causing contamination. In 1989, the Michigan Department of Natural Resources identified 379 landfills or dumps that were causing environmental contamination.

LANDFILL DIAGRAM


PLASTIC LINER
CLAY LINER
TRASH
SOIL
LEACHATE COLLECTION LINES
SAND AQUIFER
CLAY
GRAVEL

SECTION 7

HOW DOES THE QUALITY OF GROUNDWATER AFFECT LIFE ON EARTH?

Practical, Useful, Wonderful Water!

Water has many uses

Adapted with permission from " Daily Currents," A Sense of Water, Southern Arizona Water Resources Association, Tucson, AZ, 1984

SUMMARY: This activity uses verbal participation, visual materials, and drawings to identify ways that water is used.

OBJECTIVES: To show the different ways that people, plants, and animals use water, and to identify where water is found on Earth.

VOCABULARY WORDS:
pollution, ocean, glacier, usable
TIME REQUIRED: 20 minutes
MATERIALS NEEDED:
Chalk and chalkboard
Drawing materials
Scissors
Tape or paste
One magazine picture per student of water being used in different ways (students can cut these out)
1 Large piece of paper with water droplet outlined on it
2 Paper bags

PROCEDURE:

1. Draw a large drop of water on the chalkboard. Explain to students that they are going to figure out different ways that people, plants, and animals use water. Ask students to list different ways that water can be used, and write them inside the raindrop. (For example, drinking, brushing teeth, etc.) Encourage each student to come up with a different idea.
2. Cut out magazine pictures of people, plants, or animals using water. (Optional: students can do this as part of the activity.)
3. Put the magazine pictures into 2 paper bags. Ask each student to close her or his eyes and pull out one picture. Student volunteers can pass around the bags.
4. Tape the big piece of paper with the large drawing of a water drop to the chalkboard next to the chalk picture.
5. Have students come up to the chalkboard with their pictures, and tape or paste the pictures to the paper water drop.
6. Compare the uses of water in the magazine pictures to the uses listed on the paper water drop.
7. Hand out drawing paper and ask students to draw one way that plants, animals, or people use water. Older students can write a description below the picture.
8. Discussion Questions:
   a) Review the ways water is used
   b) Who depends on water? *(All living organisms.)*
   c) What happens if someone pollutes the water? What can we do about it? *(Polluted water is bad for living things—it can make them sick. If you see someone polluting the water, tell an adult. Students can be careful not to pollute water themselves by not littering. Recycling also keeps water clean, because it reduces the amount of water needed to make new materials. Buying fewer things helps keep water clean for the same reason. Can students think of other ways to keep water clean?)*
9. Leave the poster of magazine pictures hanging in the room to remind students of how they and other living things use water.

EXTENSIONS:

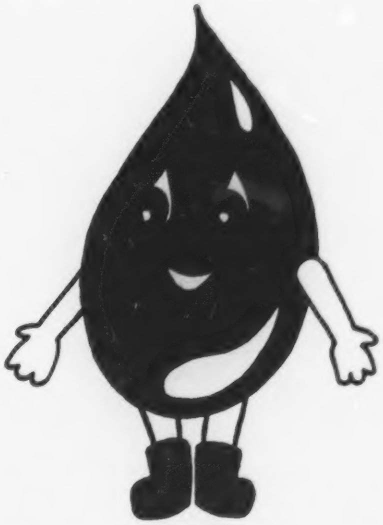
1. Have students write down two ways water is used by animals or plants, two ways water is used by humans, and three things that they can do to help keep water from becoming polluted.
2. Write a class poem or song based on a familiar tune about different ways that living things use water.

BACKGROUND:

All living things are dependent on water, and the amount of water available in a particular area is a major determinant of what organisms can live in that area. Consider the deserts, where water is relatively scarce. One main characteristic of both the plants and the animals that typically live there is that they minimize water loss. The animals tend to be nocturnal, thus avoiding the hot sun which would cause a great deal of water loss. The plants generally have very thick, waxy coverings and thin, needle-like leaves, both important in reducing water loss.

Then consider ecosystems like seasonal ponds, which are very wet during the spring but relatively dry the rest of the year. In the spring one can find tadpoles in the ponds. Later, as the ponds dry up, the tadpoles have become frogs; although the frogs need to be around water too, they do not have to be in it constantly as the tadpoles do. Here it is apparent that water not only determines what organisms can live in an area, but also how the organisms live.

While some organisms must spend their entire lives in the water, humans only need access to water to live. On average, the human body requires about 2.5 quarts (about 2.4 liters) of water per day. But we use a lot more water than is needed internally. Some estimates put the level of water use at about 240 gallons (908 liters) of water per day for an American family. Factoring in how much water gets used for industry and agriculture, too, we use about 1,600 gallons (6,056 liters) of water per person per day in the United States. In other words, we use about 2,523 times more water than the body needs to survive. Much of this goes into activities like food preparation and hygiene, but how much water is wasted by one's lifestyle? And, given the relatively small amount of usable fresh water on this planet, can we afford to be polluting our water supplies?



Water in Your School:

How does your school's water get to the faucet?

SUMMARY: This lesson consists of questioning strategies and activities to raise levels of awareness. It allows students to learn about their school's water system through prediction and observation, and why water quality is important to them.

OBJECTIVES: To connect students to their immediate environment and to find out what they already know about water.

TIME REQUIRED: 45 minutes
MATERIALS NEEDED:
Drawing materials
A maintenance staff person's time

PROCEDURE:

1. Ask students to tell you everything they know about how water moves. Write it all down as a list, on the chalkboard or on newsprint. Let them list things until they run out of ideas.
2. Ask students to list what they expect from the water at their school. *(It is drinkable, clear, cold, etc.)* Does it meet their expectations? What if they had no drinkable water available at their school? What behaviors and activities would change?
3. Ask students where the water in their school comes from, and how it moves in their school building.
4. Ask students to draw where the water in the school building comes from.
5. By speaking with the maintenance staff at your school building, you can find out about the plumbing routes in your school. Share this with your students by a quick class tour of the building with the maintenance person, highlighting pipes and the water flow of the building.
6. Ask students to draw their school's water system, incorporating their new knowledge.
7. Hang pictures side-by-side on classroom walls or a bulletin board.

EXTENSION:

1. After it is used, where does your school's waste water go? Does water go to the municipal sewage treatment plant? How does it get there? Check for clues indoors like pipes, and outdoors like storm drains and gutters. Diagram where water goes after it is used, and after it is cleaned up.

BACKGROUND:

A common area of misconception is the true source of water in a school or home. Often, water users think only as far as the tap or drinking fountain. By examining the path of water from its entrance into the building to its use, including pipes, pumps, and water heaters, an important link between the surface or groundwater source and its users is realized.

BEST COPY AVAILABLE

Plants Need Water, Too!

Experiment to see how much water plants need

SUMMARY: Water requirements of two similar plants are compared.

OBJECTIVE: To show that plants take up water from the ground.

VOCABULARY WORDS: soil, evaporation

TIME REQUIRED: 5 minutes every other day, for 2 weeks; wrap up 5 minutes

MATERIALS NEEDED:

2 Similar plants in pots or cups with holes in the bottom (small bean plants in paper cups are fine)
2 Shallow pans
Gravel
Water

PROCEDURE:

1. Fill two shallow pans with about 2" of gravel each. In each pan, set a plant of the same type and size. The plants should be growing in cups or pots that have holes in the bottom. Make sure the holes in the cups or pots are touching the bottom of the pan.
2. Set both plants in a well-lighted area.
3. Keep an inch of water in one of the pans, but no water in the other.
4. Water each plant's soil when no soil particles cling to your finger if you lay it on top of the soil—this means the soil is dry. Each day a different student can determine whether the plants need water.
5. Record the amount of water required by each plant for two weeks.
6. Discussion Questions:
   a) Which plant needed watering more often in order to keep its soil moist? *(The one in the dry pan.)*
   b) Why? *(For the plant in the dry pan, watering was its only source of water.)*
   c) Where did the water poured into the pan go? *(First, it went into the spaces between the pieces of gravel. Then, it was drawn through the soil, into the plant's roots, stems and leaves, or it evaporated into the air.)*
   d) Where do outdoor plants get their water from? *(From rain, dew, and water beneath them in the ground.)*

EXTENSIONS:

1. Construct bar graphs that record the amounts of water that the plants receive.
2. Discuss other living things that need water. Is there any living thing that does not need water to survive?

BACKGROUND:

Land plants flourish only where there is extractable water in the soil. A tree may use 50 gallons (189 liters) of water per day from this source, so frequent renewal of soil moisture by rain or irrigation is crucial. When water hits the ground as precipitation, some of it is held in the soil, where it can be absorbed by plants. A plant absorbs water much like a sponge does, actually pulling the water up into it.

The zone of soil moisture refers to the water in the top 5 feet (1.5 m) of soil and rock material, where pore spaces between particles of earth materials contain both air and water. Plants have their roots in the zone of soil moisture. If we were to dig below this zone, we might encounter several feet of dry soil before reaching the top of the water table.

The average amount of soil moisture at any given time is approximately 6,000 cubic miles for the entire earth; a small percentage of the world's total water supply, but vital to life. Relatively little plant life is irrigated artificially, so the hydrologic cycle is critical to the earth's vegetation.

A World of Circles:

A look at the water cycle and how water gets polluted or stays clean

SUMMARY: Students discuss the role of circles and cycles in the environment, then color and paste an illustration of this point. They see and discuss actions which create both clean and dirty water.

OBJECTIVE: To demonstrate how human actions and environmental consequences are connected.

VOCABULARY WORDS: circle, cycle, globe, pollutant, groundwater, motor oil, polluted

TIME REQUIRED: 15 minutes

MATERIALS NEEDED:

Globe
Earth poster
One copy of Worksheet A, and one of Worksheet B for each student
Scissors for each student
Drawing materials
Paste

PROCEDURE:

1. Ask students to describe characteristics of circles. *(They are round, continuous, etc.)*

2. Show a poster of the Earth and a globe. What shape is the Earth? *(Circle, sphere.)* What are other circles the students think of when looking at the poster and globe? *(The Earth goes in a circle around the sun, the sun and other stars are round, etc.)*

3. Cycle is a word meaning circle. What words can students think of that have the word cycle in them? *(Bicycle, tricycle, motorcycle, etc.)* What is shaped like a circle in all these things? *(The wheels)*

4. Use the flannel board cutouts to explain the water cycle (patterns for cutouts provided, as is a diagram of the water cycle). Review its parts. Explain that the water cycle is a circle, too. *(The same water is circulated over and over. Water is never gained or lost when it is used, its form or its quality is just changed. The same water travels through the water cycle over and over, in a "circle.")*

5. Hand out Worksheet A. Describe for students the behaviors that pollute water. These are shown in the picture as: putting garbage into a landfill, where it can pollute groundwater that flows under it; a company putting polluted water into the lake and polluting the air; applying too much fertilizer to plants, which soaks into the ground and can pollute groundwater; pouring used motor oil on the ground, which can pollute groundwater.

6. Have students cut out the water vapor and polluted raindrops at the bottom of the worksheet. The water should be pasted onto the worksheet above the lake and landfill, and in the cloud. Polluted water droplets should be glued on over the rain shower and the pond or tree in the picture, and under the ground below the landfill, by the pollution from the company, and under the oil spill caused by pouring used motor oil on the ground.

7. Discussion Questions:

a) Look at the pictures on the worksheets to see what is causing the problems. *(Pouring used motor oil on the ground instead of recycling it; a company polluting the water; throwing things in a dump; using too much fertilizer.)*

b) What are the ways in which each of us can help stop these problems? *(Encourage parents, brothers, and sisters to take used motor oil to a gas station or recycling station that recycles it; do not put chemical fertilizers on lawns; do not buy things that come with extra packaging; do not buy things that can only be used once , then are thrown away; recycle your newspapers, glass, and cans; reuse things instead of throwing them away; etc.)*

8. Hand out Worksheet B. The solutions drawn on Worksheet B include recycled motor oil, recycled solid waste, a company with better pollution control no fertilizer used. Results include a healthy and happy tree and pond, and clean cloud and rain, and clean water underground (groundwater).

9. Have students cut out the clean air and clean raindrop

drawings on the bottom of the page. The clean air should be glued above the recycled materials, the clean factory, and in the cloud. The clean droplets should be pasted on in the rain shower, on the healthy tree or pond, and in the ground under the materials ready for recycling.

10. Have students cut around the dotted line on their Worksheet B to make it into a circle. If there is time, they can color in the worksheet.

11. Turn over the worksheet and have each student draw a solution that they will use to help stop surface water or groundwater from becoming polluted. Have them take the project home to show to their family.

12. Sit in a circle and have students pass a cup of water to each other. As each student holds the cup, s/he should tell the group what the "solution" that s/he drew on the back of their worksheet was (how they will help keep surface water or groundwater from becoming polluted).

BACKGROUND:

When thinking about groundwater quality, it is very important to note that as water moves from the surface of the earth down to the water table it will pick up much of the material found in the soil it passes through. Water will also pick up things from the atmosphere.

What sorts of substances is the water likely to come in contact with? There may be naturally- occurring minerals like copper and iron in the soil or dust in the atmosphere. There may also be substances that originated from human use, and many of these can pollute groundwater.

One threat to groundwater quality is the landfill. Old landfills, called "dumps," were often unmanaged pits or piles of refuse that easily contaminated nearby ground and surface water. Landfills built under current regulations, called sanitary landfills, have clay and/or plastic liners, water retrieval systems, and refuse that is compacted and covered with soil at regular intervals.

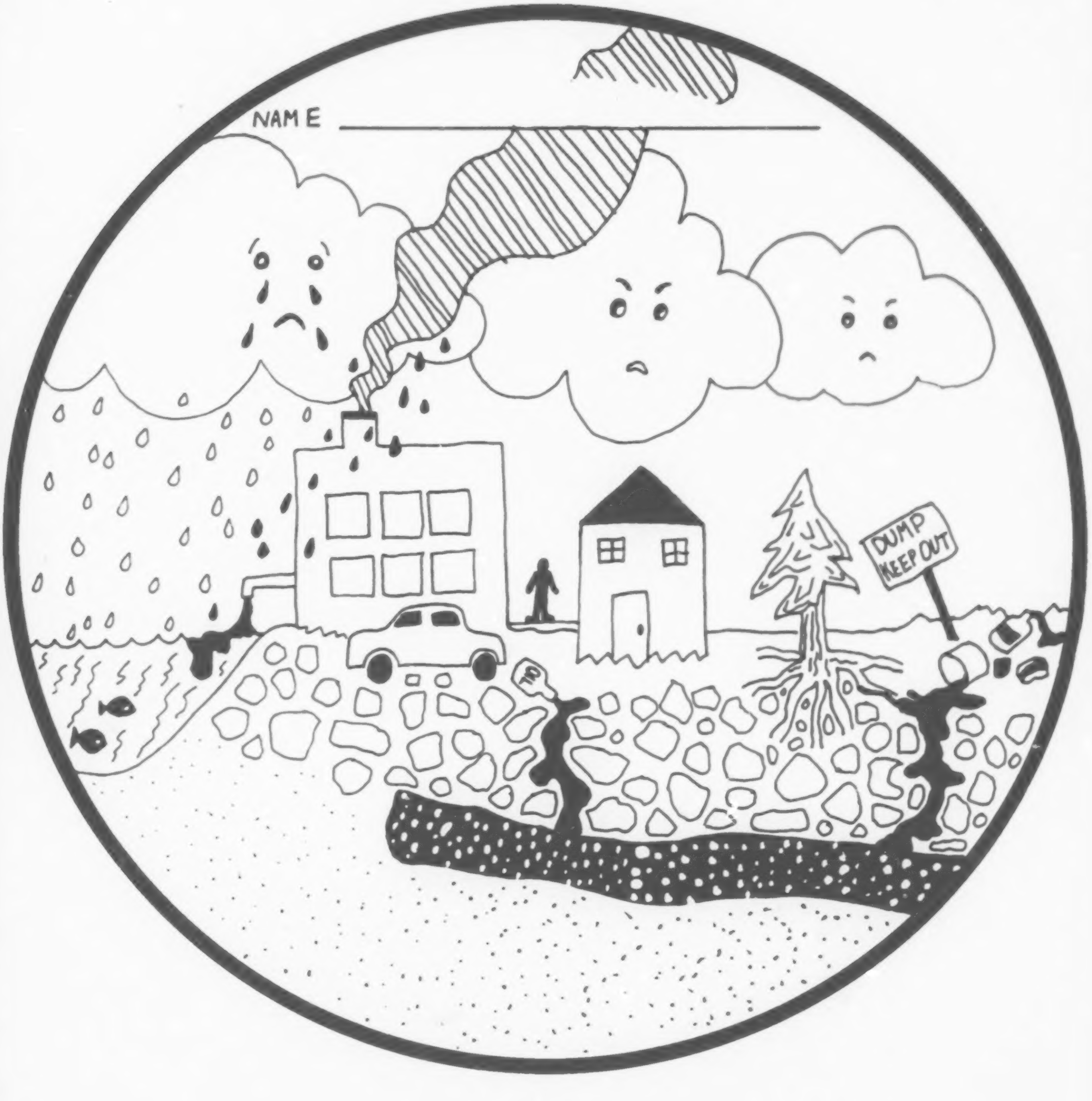
Water from precipitation will move down through a landfill just like it would through the Earth's surface. A landfill may contain many harmful substances. Some of these are discarded household toxins like cleaners, solvents, batteries, etc. (Depending on the type of landfill, there may be toxins from other sources as well.) As the water percolates through the landfill, it will pick up some of this toxic material if it comes in contact with it. If not blocked, these substances will then make their way into the groundwater. To prevent that from happening, new landfills are required to have a liner underneath them. Unfortunately, these liners are not always leak-free. According to the Michigan Department of Natural Resources (MDNR), landfills are the sources of contamination for 20% of all the contaminated groundwater sites in Michigan.

A second serious threat is pollution from industry. This may be in the form of substances being discharged directly into bodies of water or into the ground, or it may be in the form of pollutants discharged into the air. Substances discharged into the air often come back down to earth in precipitation (as with "acid rain"). MDNR figures show that manufacturing is the source of contamination for 25% of all the contaminated groundwater sites in Michigan.

The overuse of pesticides and fertilizers also threatens our water supplies. Excessive amounts of these substances may be carried by run-off directly into surface waters, or they may be leached down to groundwater through infiltration.

Another threat to water quality is the improper disposal of substances around the house. One example of this is the way many people dump motor oil down the drain or on the ground when they change their car's oil. Not only does this pollute the water, it is also very wasteful: used motor oil can be recycled. In Michigan alone, 11 million gallons of used motor oil were dumped on the ground or landfilled in 1989 by do-it-yourselfers.

ACTIVITY 7D A WORLD OF CIRCLES WORKSHEET A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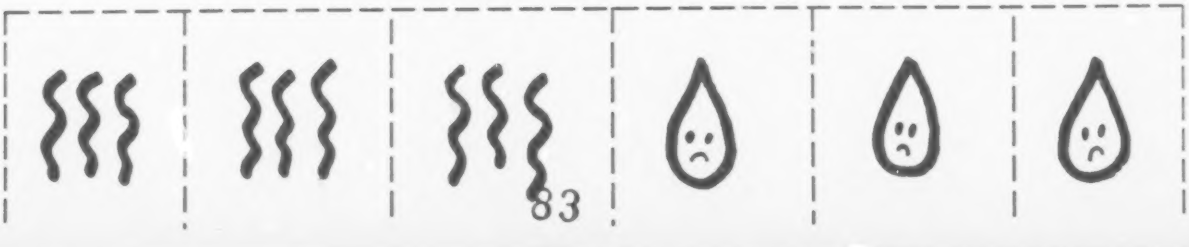
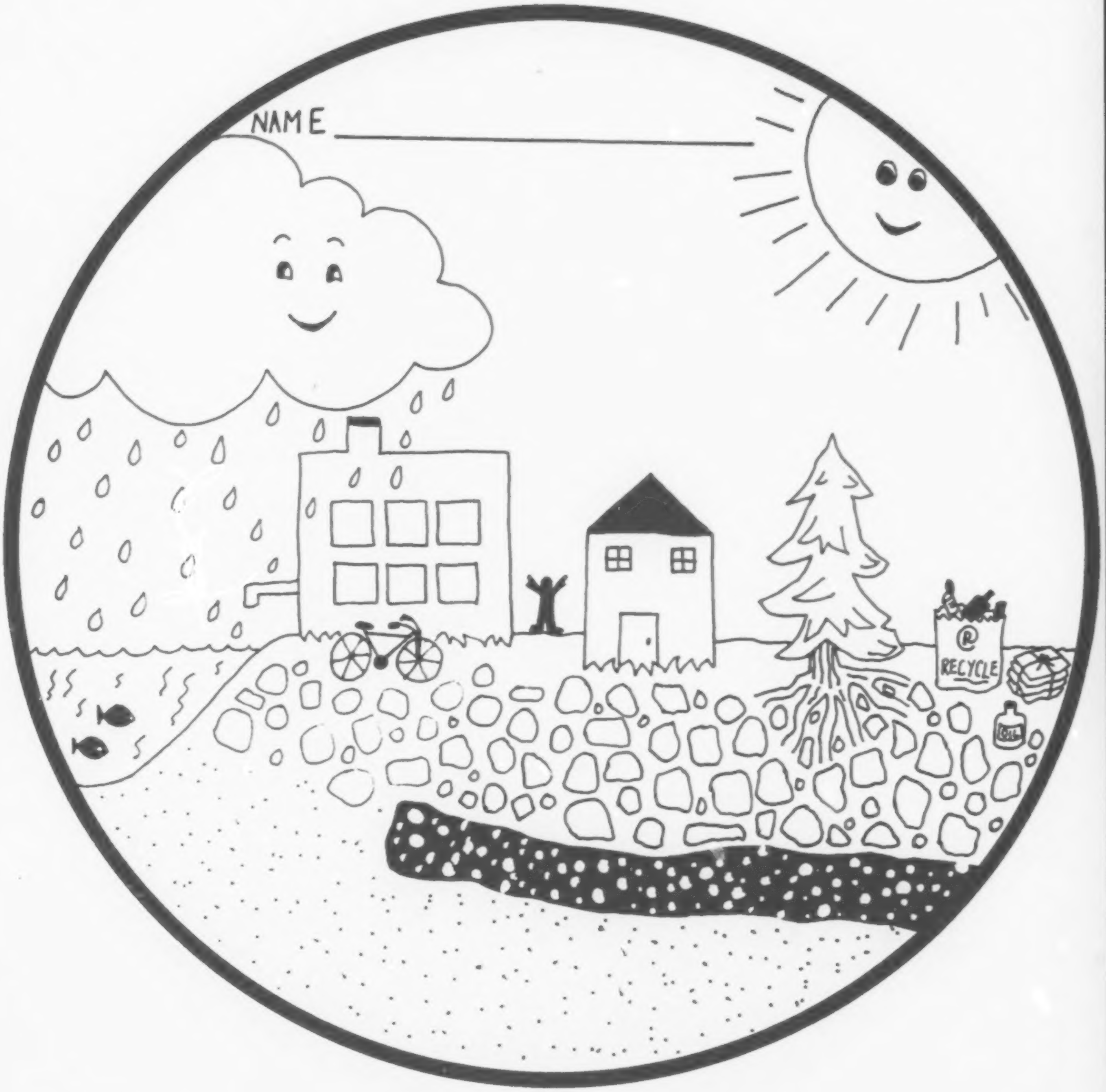
DUMP KEEP OUT



ACTIVITY 7D A WORLD OF CIRCLES WORKSHEET B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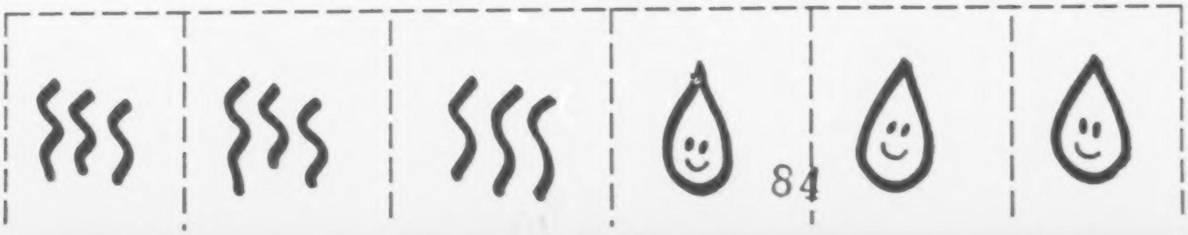
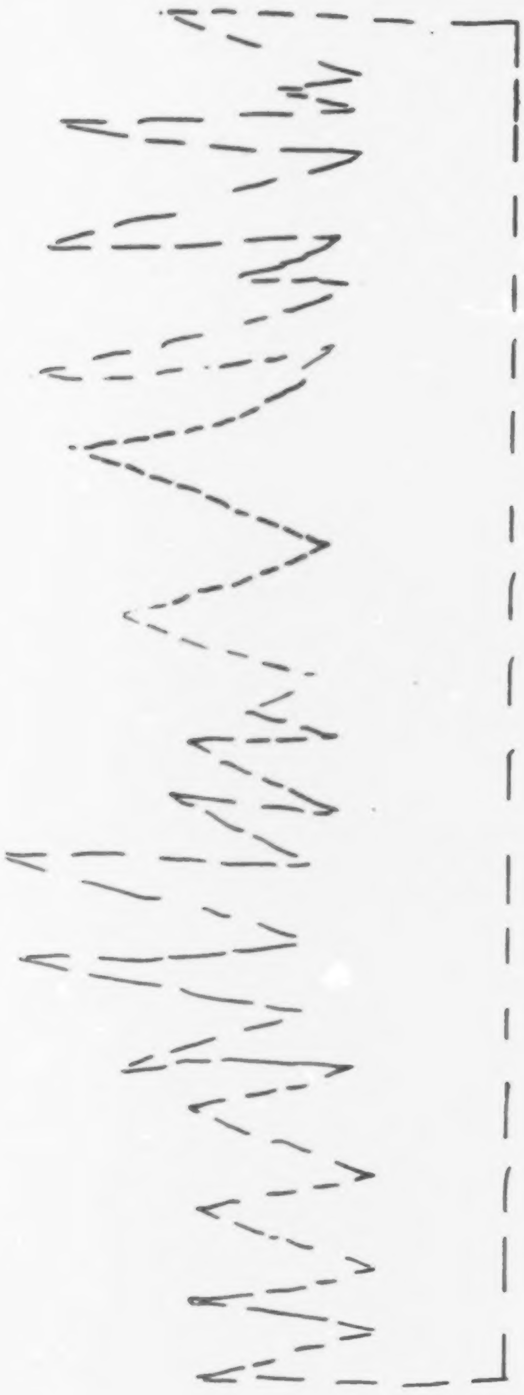
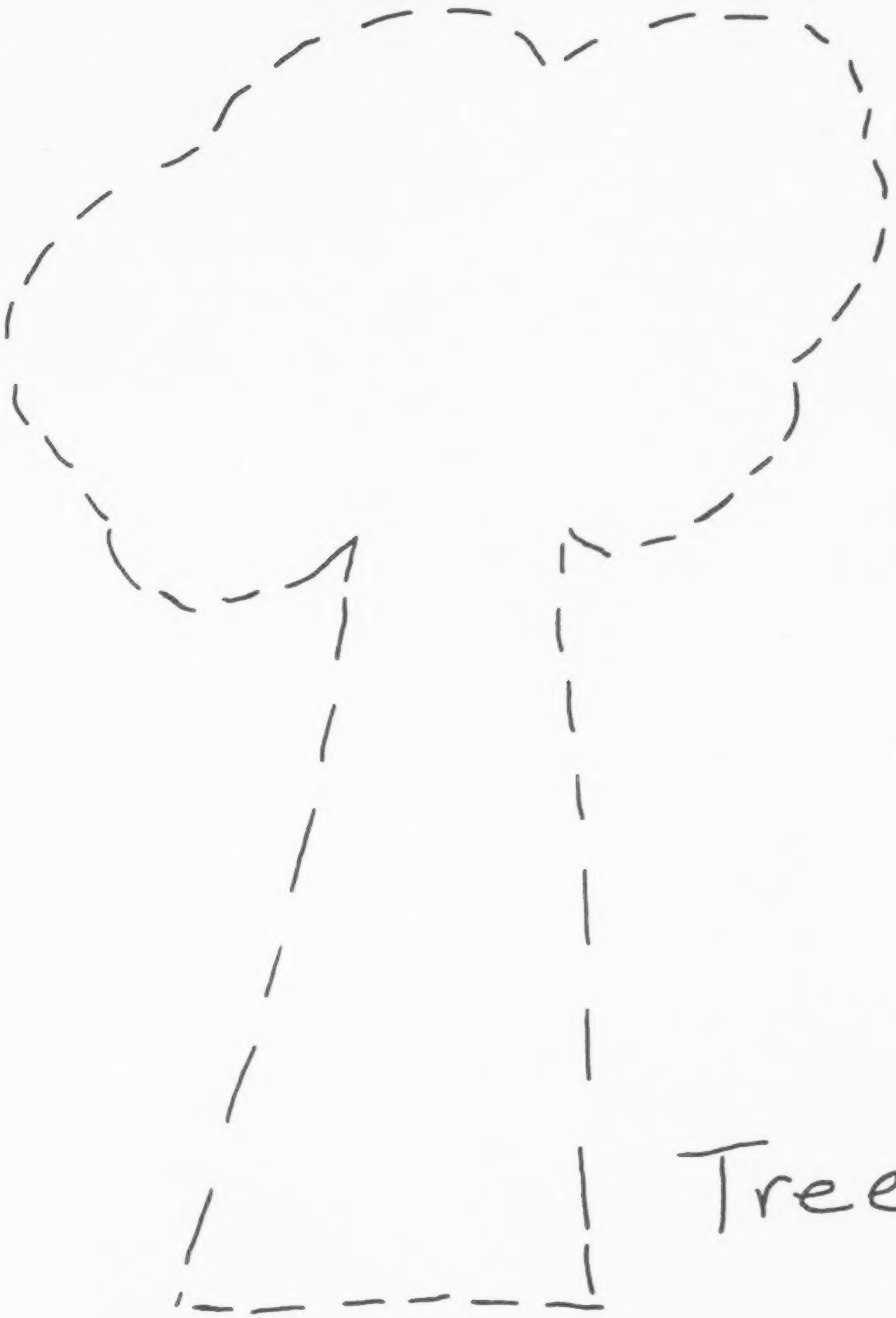
RECYCLE
OIL





Grass

(Can be used as border, below which water droplets can infiltrate.)



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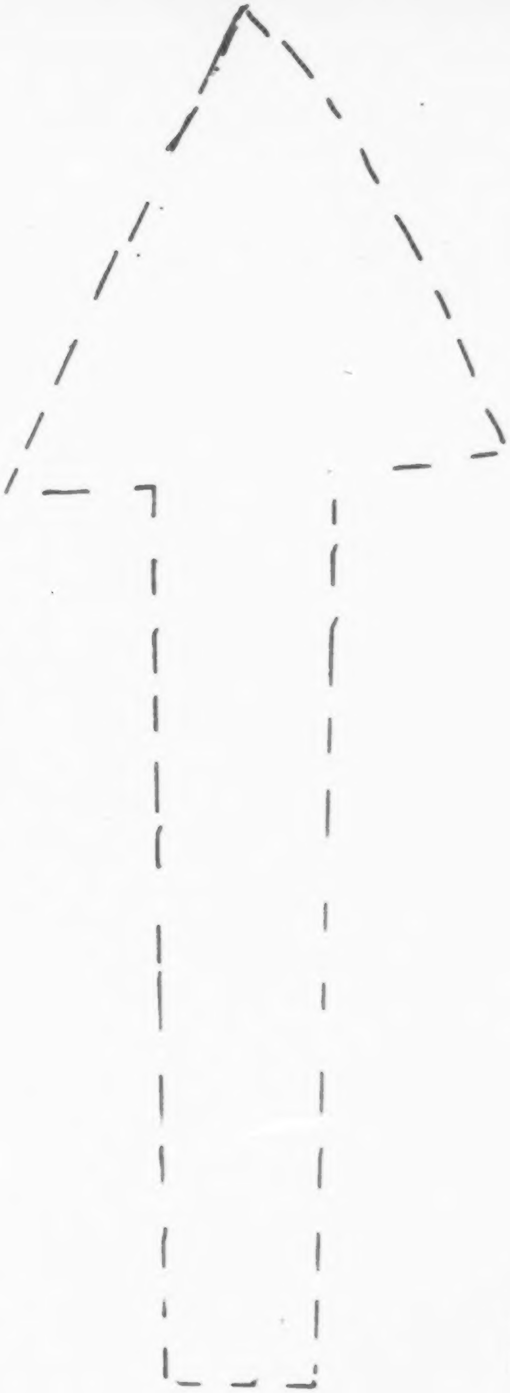
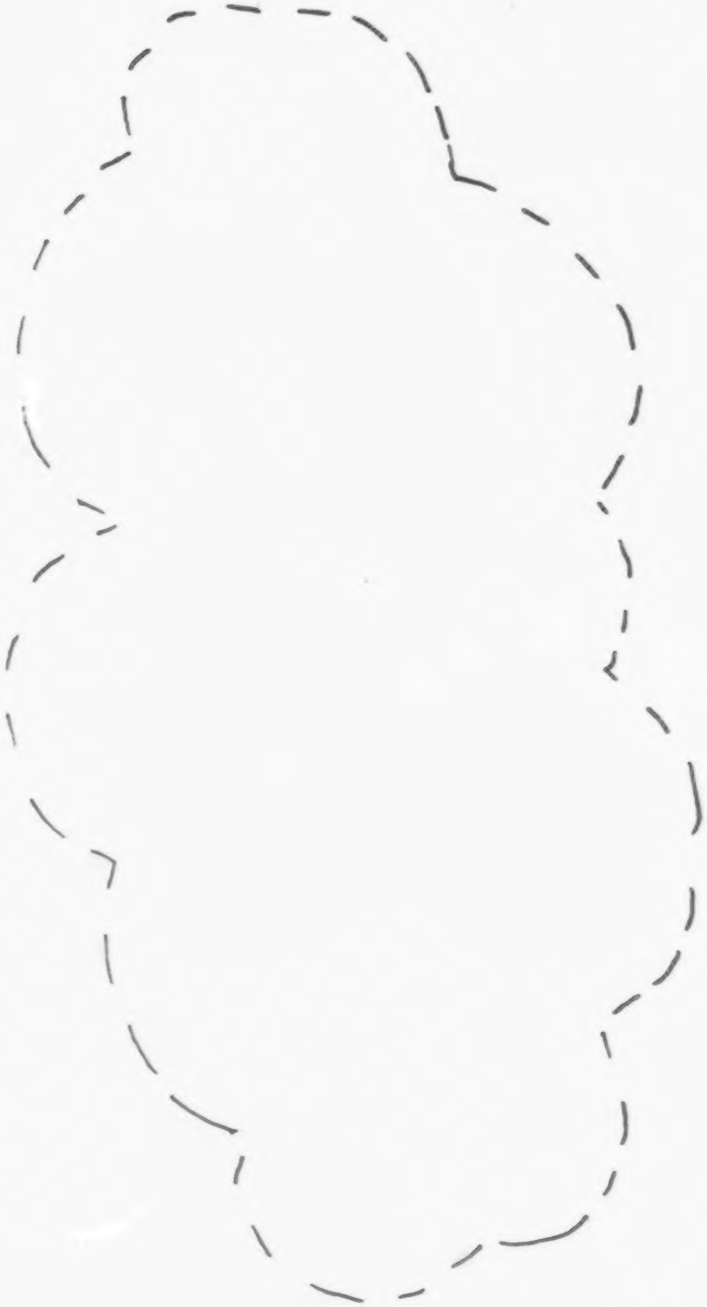


Arrows



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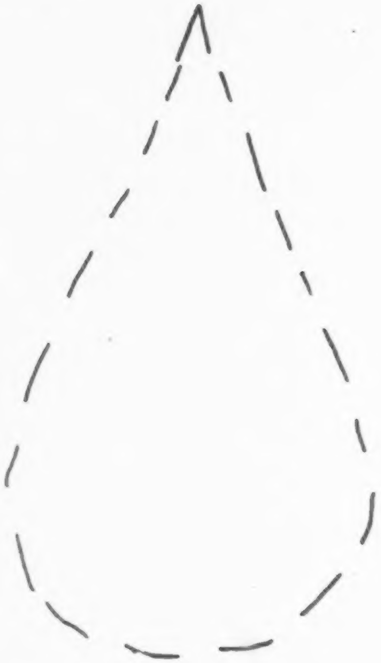
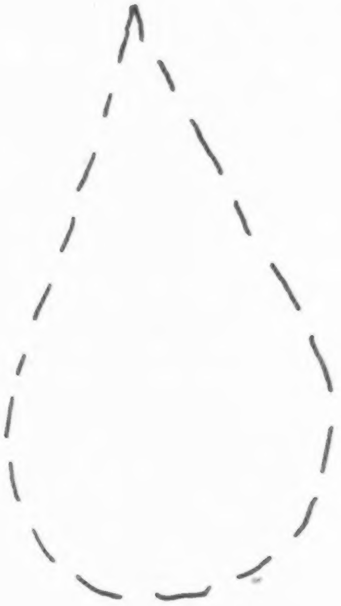
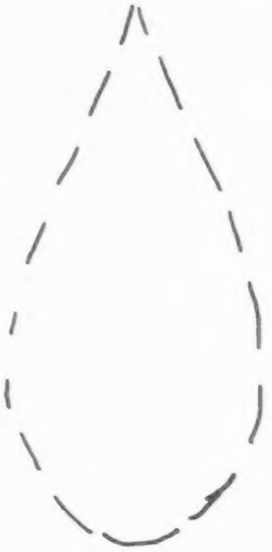
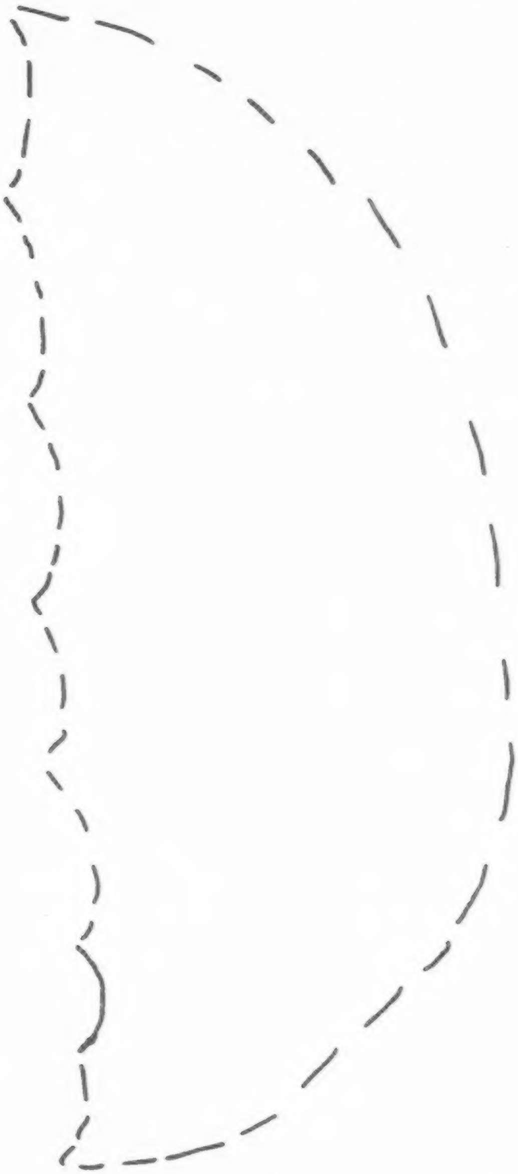


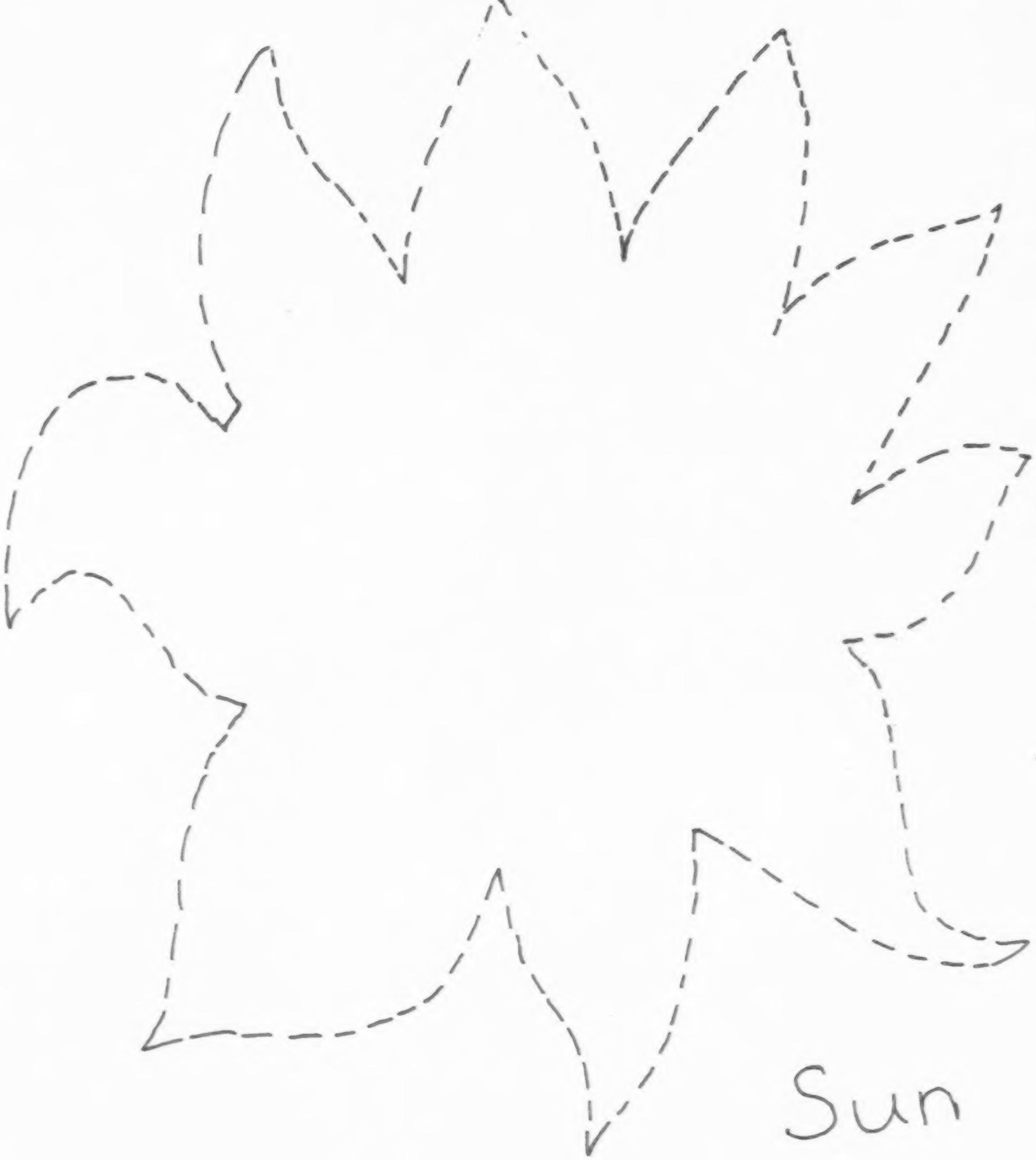




Water
Droplets



Lake



Sun

SECTION 8

HOW CAN WE PROTECT THE QUANTITY AND QUALITY OF GROUNDWATER?

Paste the Waste and Amazing Maze:

Worksheets on what trash is and is not

SUMMARY: Worksheet A has objects that may end up as trash when we finish using them. Students will cut out these objects and paste each one in the proper category of Worksheet B: "Recycle," "Compost," "Reuse," and "Landfill." Students can also list "Alternatives" (if an item that is more environmentally sound could be substituted for any of the items). Worksheet C allows students to discover how pollutants from household hazardous wastes can reach groundwater, which people may use as drinking water.

OBJECTIVES: The worksheets show how to reduce the amount of waste that ends up in a landfill, and how careful we must be to ensure that household hazardous wastes do not contaminate groundwater.

VOCABULARY WORDS: landfill, well, pollutant, groundwater, hazardous, natural resource, alternative

TIME REQUIRED: Part I: 15 minutes; Part II: 5 minutes

MATERIALS NEEDED:

A copy of each worksheet for each student
Crayons
Paste

PROCEDURE:

PART 1: Paste the Waste

1. Discussion Questions:

a) What is a landfill? *(Students may commonly, but incorrectly, refer to a landfill as a "dump." A dump is a hole in the ground that is used for trash disposal, or just a pile of trash. The newer sanitary landfills are pits that have liners of clay and plastic, and pipes which collect polluted water. In these types of landfills, it is more difficult for water with pollutants to leak into the ground and groundwater under the landfill. The waste in sanitary landfills is regularly compacted and covered with a layer of soil.)*

b) Do you recycle at home? Do you bring soda pop bottles and cans back to the store? Does your family compost? Do you ever receive hand-me-down clothing from neighbors or older brothers or sisters? *(It is becoming more and more expensive to put trash in a landfill. It is better to reuse, recycle or compost our trash, if possible, than to put it underground forever. That way, we save land, trees, metals, sand (used to make glass), landfill space, energy, etc.)*

c) What happens to your trash if you throw it in the trash can in your classroom? *(It goes from the trash can to the school's dumpster, then into a garbage truck and into a landfill.)*

d) What happens to it once it is in the landfill? *(It may or may not eventually break down into tiny particles. Scientists have found that materials in landfills are usually compacted so tightly that air conditions are not suitable to bacteria needed ito break the materials down. Materials in a landfill can contaminate the water underneath the landfill if there is a leak in the liner or no liner at all. Water carries dissolved and liquid wastes down with it through the sediment and into the groundwater.)*

e) What is a natural resource? *(A material that comes from nature, such as oil, trees, coal, etc., and can be used for making products, producing energy, recreation, etc.)*

f) Where does the water that you drink come from? *(It may be from a nearby lake, river, or reservoir, or from a municipal or private well. Half of the people in the United States use groundwater as their source of drinking water.)*

g) How is the water you drink related to the landfill? *(Water under landfills and other places under the ground, called groundwater, travels through the ground. Some groundwater travels into lakes and rivers. Leaking landfills can contaminate the water that we drink now, or that we would like to use as a source of drinking water later.)*

2. Give your students Worksheets A and B. Have them cut out the various waste items on Worksheet A. (Optional: color the items.)

3. Have students paste each waste item onto Worksheet B under the most appropriate category. You may also choose to tack up one large piece of paper at the front of the classroom with these categories, and have individual students paste one item each. Make sure your students realize that landfilling waste should only to be

used as a last resort.

4. Discuss the choices that your students make, and which items they landfill may eventually leak pollutants into groundwater.

Part II: Amazing Maze

1. By brainstorming with your students, come up with a list on the blackboard of possible household hazardous wastes. *(These include strong cleansers, paint, and pesticides, drain cleaners, shop materials, etc.)*

2. Hand out Worksheet C, and explain to students that the three items at the top represent household hazardous waste materials that were put out in someone's trash and are now in a landfill.

3. Explain that small amounts of chemicals remain in the containers and may leak out. When it rains, the water carries these pollutants down to the bottom of the landfill. If there is no liner around the landfill, or if there is a hole in an existing liner, the pollutants can leak into the ground and groundwater below the landfill.

4. Have your students color each item a different color. Then, with the same color for each item, trace the path(s) that the pollutants from each item could possibly take through the bottom of the landfill, into the ground and groundwater, and maybe even into a nearby lake or river that people use for drinking water. For instance, if a student colors the empty paint can green, he or she should make the path leading from that can green as well, and then use a different color for the bottle of used motor oil.

BACKGROUND:

More and more, people are becoming concerned with the amount of waste that is sent to landfills. Landfills are quickly filling up, and it is increasingly difficult to site new ones because nobody wants a landfill in their "backyard."

Landfills have also become a very costly means of disposing of waste. During the period from 1984 to 1986, the fees for dumping waste at municipally owned landfills in Michigan increased by 40-57%, while fees at privately owned landfills increased by 22%. They are sure to increase even more dramatically in the future.

In addition to monetary costs, there are also environmental costs. Containers that once held household cleaners may still contain residue when they are taken to the landfill. This residue can dissolve in rainwater that travels down the landfill and can affect the quality of groundwater surrounding the landfill. Also, in Michigan, once land has been used for a landfill, it can no longer be used for any intensive public purpose, such as housing. Therefore, a valuable natural resource—land—is wasted.

It has become both economically and environmentally desirable to divert as much material from landfills as possible. Fortunately, there are many items in the waste stream that are reusable, compostable, or recyclable.

EXAMPLES OF ITEMS IN CATEGORIES:

REUSABLE
Old clothes
Jars
Plastic and paper bags
Plastic containers
Boxes
Old furniture
Used appliances
Magazines
Plastic silverware
Egg cartons
Broken toys (can be fixed)
Odds and ends (for craft projects)
Scrap lumber
Cloth scraps (for rags)
This list can grow and grow...be creative!

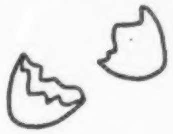
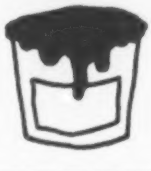
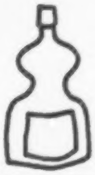
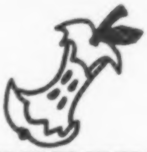
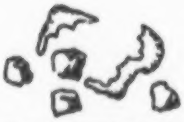
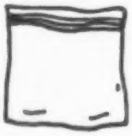
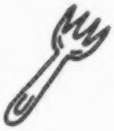
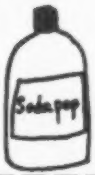
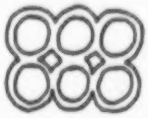
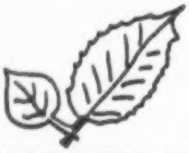
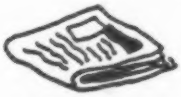
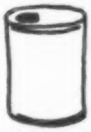
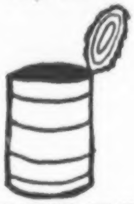
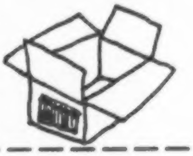
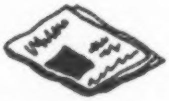
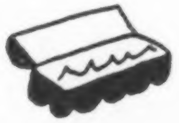
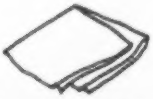
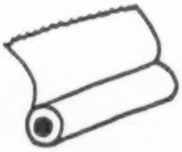
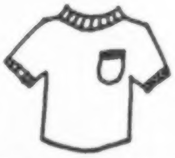
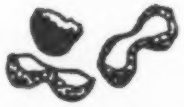
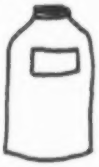
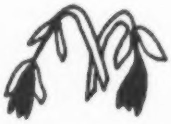
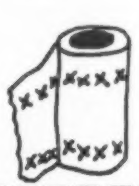
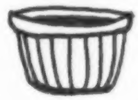
COMPOSTABLE
All food waste except meat, fat, citrus rinds
Newspaper

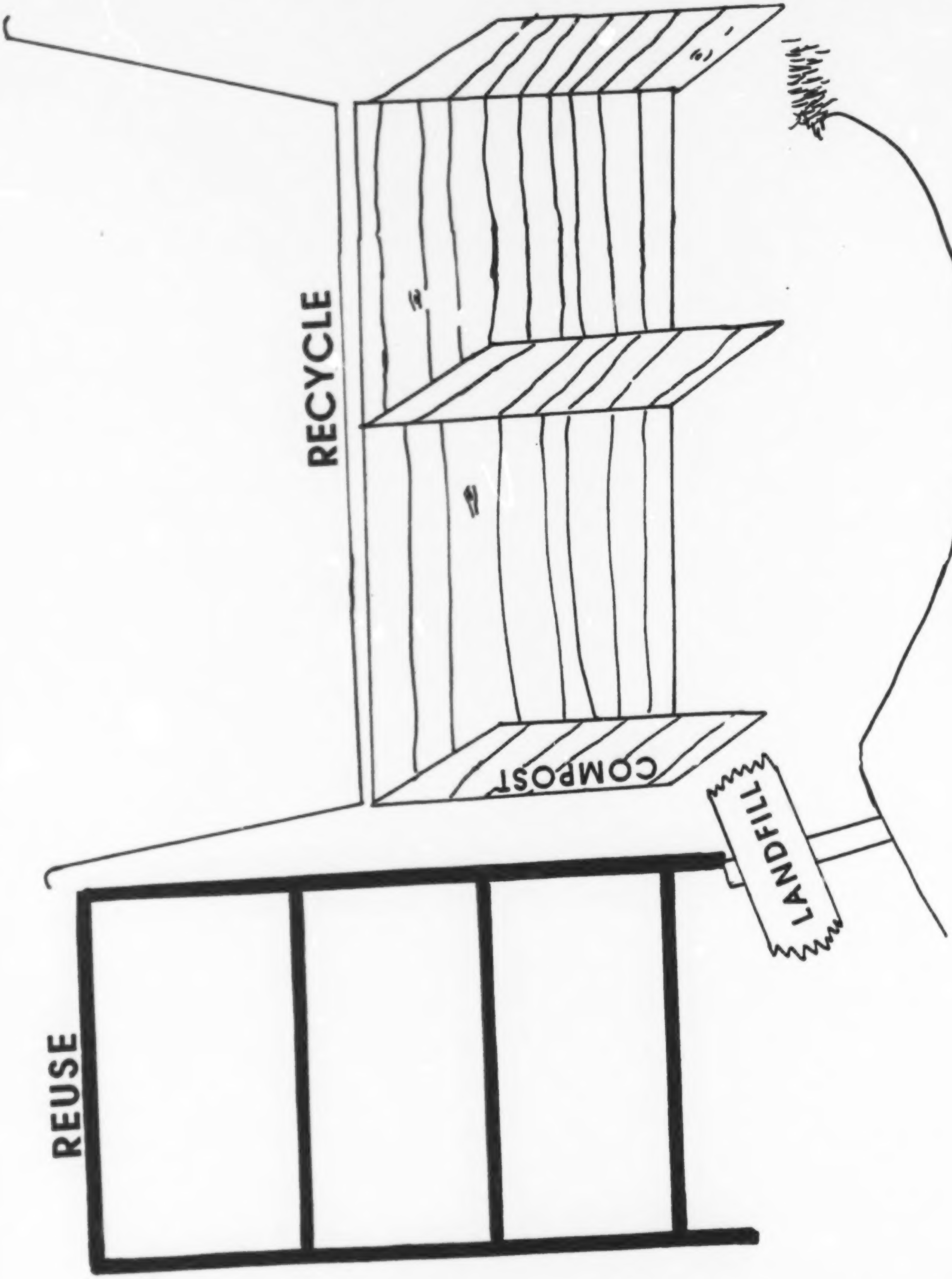
RECYCLABLE/FROM A RESOURCE THAT WILL BUILD BACK UP
Newspaper
Cardboard
Magazines and catalogues
Brown paper bags
Office paper
Colored paper
Computer printout paper
File folders
What is recyclable in your area varies with the recycling program in your community

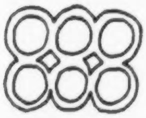
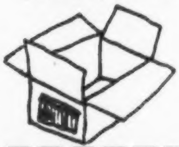
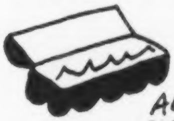
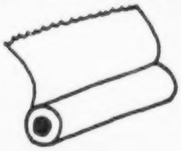
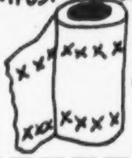
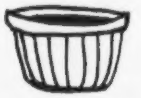
RECYCLABLE/FROM A RESOURCE WHICH WILL NOT BUILD BACK UP
Used motor oil
Aluminum (made from bauxite ore mined out of the ground)
Metal cans (made from various minerals mined our of the ground)
Glass (made from sand which is mined from sand dunes and deposits)
Copper (made from copper mined out of the ground)
Plastic (made from oil)
Car and household batteries (made from several mined metals)
Appliances that cannot be repaired (made from several materials)
What is recyclable in your area varies with the recycling program in your community.

HARD TO REUSE, COMPOST, OR RECYCLE
Toothpaste tubes
Plastic packing materials
Paper napkins and paper towels
Dental floss
Cat litter
See if your students can think of others, or if they can figure out safe ways these can be reused!

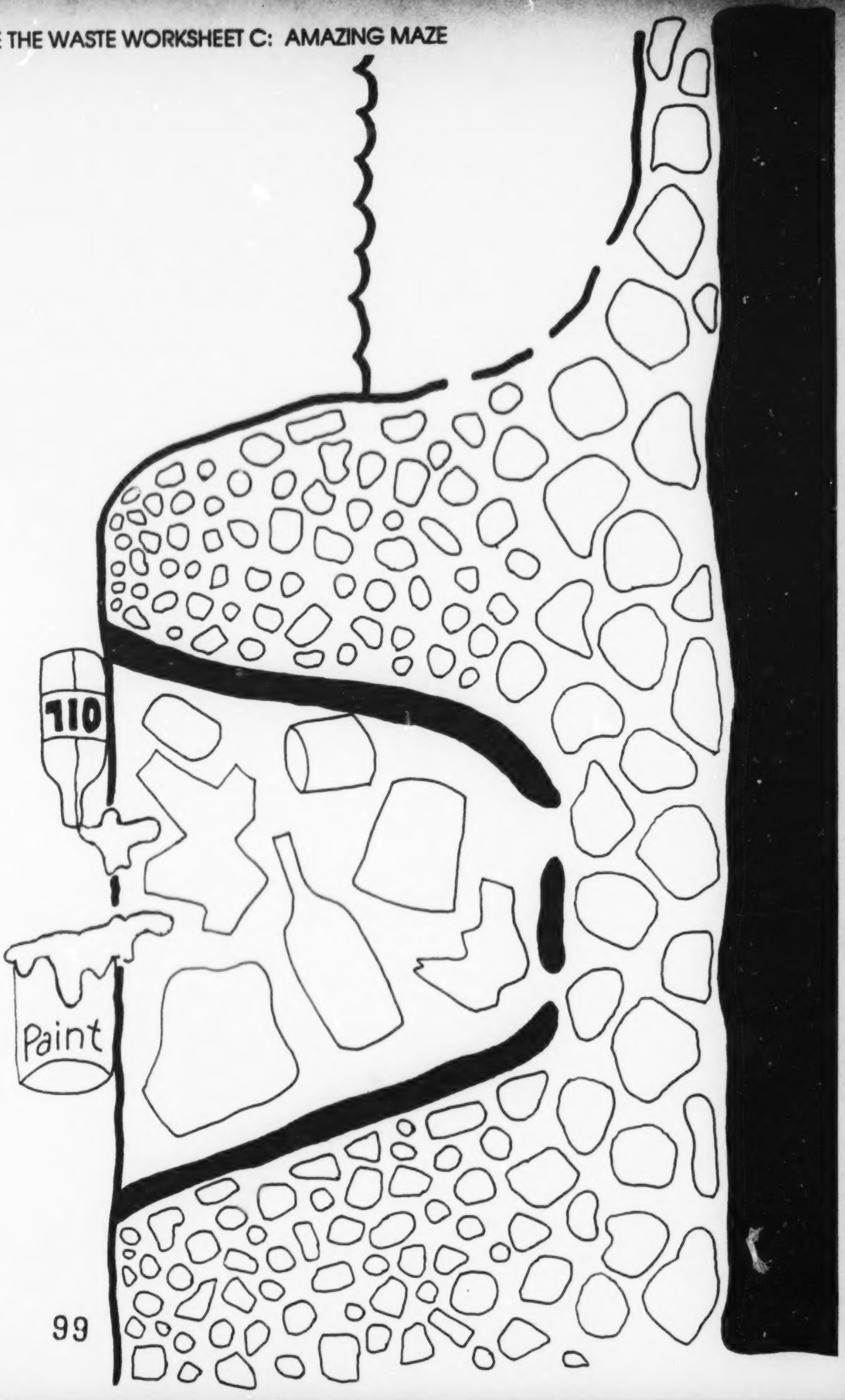
PASTE THE WASTE WORKSHEET A

Egg shells 	Paint can 	Dish detergent bottle 	Apple core 
Bread crumbs 	Plastic bag 	Plastic fork 	Plastic soda bottle 
Plastic 6-pack ring 	Leaves 	Newspaper 	Aluminum can 
Soup can 	Corrugated cardboard box 	Magazine 	Egg Carton 
Paper napkin 	Aluminum foil 	Shirt 	Nut shells 
Glass juice bottle 	Withered flowers 	Paper towel 	Plastic container 


RECYCLE
COMPOST
LANDFILL
REUSE

Egg shells COMPOST 	Paint can LANDFILL OR REUSE: GIVE EXTRA PAINT TO NEIGHBOR	Dish detergent bottle LANDFILL OR RECYCLE 	Apple core COMPOST
Bread crumbs COMPOST 	Plastic bag REUSE 	Plastic fork REUSE ALTERNATIVE - SILVERWARE	Plastic soda bottle RECYCLE/LANDFILL ALTERNATIVE RECYCLABLE GLASS BOTTL
Plastic 6-pack ring LANDFILL 	Leaves COMPOST 	Newspaper RECYCLE 	Aluminum can RECYCLE
Soup can RECYCLE 	Corrugated cardboard box RE-USE/RECYCLE 	Magazine RE-USE/LANDFILL GIVE TO LIBRARY RECYCLE 	Egg Carton RE-USE/LANDFILL PLANT SEEDS  ALTERNATIVE: BU CARDBOARD NOT STYRO
Paper napkin LANDFILL OR COMPOST SMALL AMOUNTS ALTERNATIVE: CLOTH	Aluminum foil REUSE AND RECYCLE 	Shirt RE-USE/GIVE AWAY 	Nut shells COMPOST
Glass juice bottle RECYCLE 	Withered flowers COMPOST 	Paper towel LANDFILL OR COMPOST SMALL AMTS.  ALTERNATIVE: CLOTH	Plastic container RE-USE 

ACTIVITY 8A PASTE THE WASTE WORKSHEET C: AMAZING MAZE



The Old Oaken Bucket:

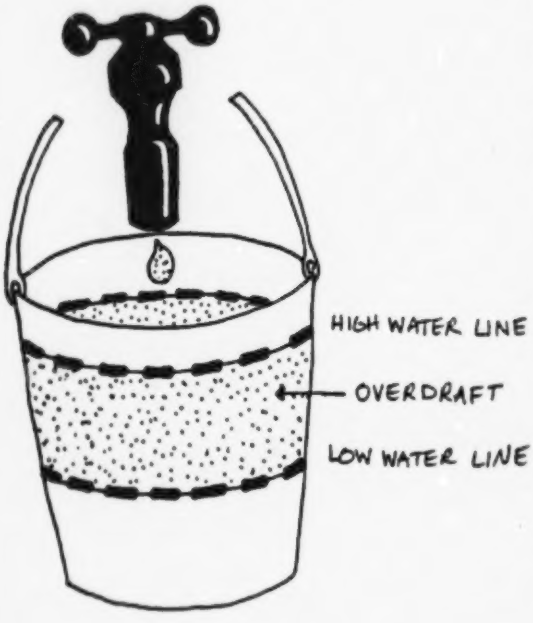
Water conservation and a model aquifer

Adapted with permission from A Sense Of Water, Southern Arizona Water Resources Association, Inc., Tucson, AZ, 1984

SUMMARY: Students will obtain drinking water only from a bucket which is slowly being filled by a dripping faucet. This drip represents recharge, and the bucket an aquifer.

OBJECTIVE: Students will be able to illustrate the recharge of a water supply.

VOCABULARY WORDS: recharge, overdraft, source, conserve, aquifer
TIME REQUIRED: 24-hour period
MATERIALS NEEDED:
Faucet
Container with open top
1 Paper cup for each student
1 Dipper



PROCEDURE:

PART I:

1. Fill a container with water under a faucet in or near your classroom. Mark the water line. The container must have a wide opening to allow the faucet to drip slowly into the container in a later part of the lesson. Have a dipper available.

2. Give each student 1 paper cup which they must take care of and use for the entire day. All drinking water must be obtained by dipping into the "bucket." (Of course, students still have outside water sources available to them outside of class time.)

3. Mark the water line at the end of the day. This line is the "overdraft," the amount of water withdrawals that exceed recharge.

4. Have students measure the amount of overdraft. Discuss how long it took to go from the full bucket to the overdraft, and how many cups of water they used.

PART II:

1. Put the bucket under the dripping faucet at the end of the day. Allow water to drip overnight into the empty container. (Be sure to tell the maintenance person to let the faucet keep dripping overnight.)

2. In the morning, measure how much water is in the container. How many cups did they gain, and how long did it take? This is the "recharge" amount.

PART III:

1. After measuring the amount of "recharge" and "overdraft," older students can calculate how many cups of water they need, and how long it takes their "aquifer" to recharge to keep up with their needs.

2. Discussion Questions:

a) If the bucket were a real aquifer, how would it get recharged? *(Groundwater recharge occurs in areas of permeable ground, in some wetlands, and some lakes and ponds. In these places, rainwater or water collecting from the surrounding area seeps below the ground to recharge aquifers.)*

b) Through water conservation techniques, an aquifer's overdraft can be reduced, and it can be made to last longer. With the class, list water conservation ideas. *(Ideas could include:*

Turn off the faucet when not in use; for example while brushing teeth;

Don't run tap water until it gets cold enough to drink—instead, keep a jar of water in the refrigerator;

Wash the car with short spurts from the hose. Water near plants, so they get a "free drink;"

Use garbage disposals as little as possible. Instead, compost your food waste or feed it to a pet (with parent's permission);

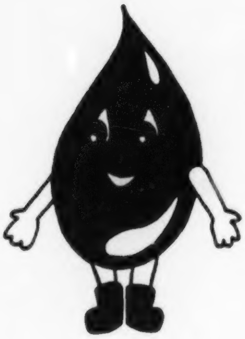
When washing dishes by hand, remove food before putting into *washwater. Rinse dishes all at once.*

Water the lawn and garden slowly and thoroughly and as infrequently as possible. Watering at night minimizes evaporation.

Do not flush non-sewage down the toilet. Do not flush more often than needed.)

Can students think of more ways to conserve water?

3. Another way that an aquifer can last longer is if its recharge areas are protected. By protecting possible recharge areas such as areas of permeable soil, wetlands, streams, and ponds, from development and contamination, our aquifers can be better guaranteed safe recharge. How can we protect these areas? *(With laws that limit paving of permeable areas, by keeping pollution out of our lakes and ponds, by limiting building on wetlands, etc.)*



BACKGROUND:

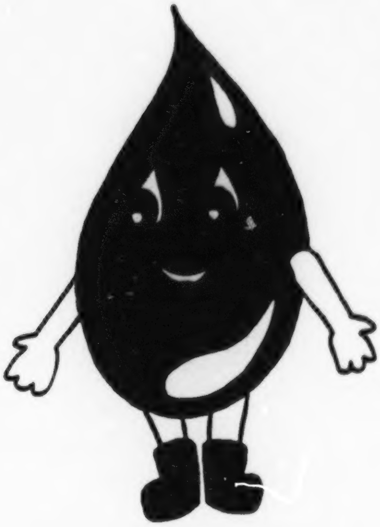
Groundwater is formed as water from precipitation moves down through the Earth's surface and fills the spaces between particles. In some parts of this process the water may be moving as slowly as a few inches per century. In contrast to this relatively slow infiltration process, humans tend to draw water relatively quickly. In Michigan we use about 11.6 billion gallons (44 billion liters) of water each day. In some areas (such as the arid state of Arizona) there is what is called an overdraft– more water is taken out of the ground (by humans) than is put back into the ground. In such a situation, the rate of recharge is less than the rate of usage.

Even though there are not drastic water shortages in Michigan, it is important to remember that the recharge of aquifers is generally slow. In Michigan, there is not an overdraft situation regarding groundwater; the rate of groundwater recharge is greater than the rate of groundwater withdrawal even in areas of heavy use. However, many students will not always live in a place with abundant groundwater reserves. In addition, the concept of treating our resources more wisely needs to be taught. Toward that end, there are a number of water conservation techniques that can be used at both the individual and organizational levels.

Water Tripping:

A water conservation game

Adapted with permission from A Sense of Water, Southern Arizona Water Resources Association, Inc., Tucson, AZ, 1984



SUMMARY: Students are given a limited amount of tickets with which to "buy" their water for several days. This leads to serious thought about water use and water conservation.

OBJECTIVES: To have students think through how people use water. To determine that water is essential to everyday living and that water is a part of the standard of living to which we are accustomed in our society.

VOCABULARY WORDS:
conservation, supply
TIME REQUIRED: 15 minutes first day; 15 minutes third or fourth day
MATERIALS NEEDED:
30 copied tickets (3 sheets) for each student
1 Envelope for each student
Collection box for tickets

PROCEDURE:

1. Tell students that the class is going to play a game that demonstrates water use and the reasons for conserving water.

2. As a group, list trips students take during a school day when they use water. Charge one ticket for each use of water on each trip. (Categories may include: drinking fountain, rest room, lunch, recess, etc.)

3. Give each student 30 tickets and an envelope in which to keep them. Have each student put her or his name on the tickets.

4. It costs the students one ticket each time they use water. Use a central collection box.

5. Have students keep a record of their water use.

6. Discussion Questions on the third or fourth day:

a) On what kinds of things have you spent your water tickets? On some activities more than others?

b) What if there were no water tickets left for the rest of the week?

c) What can we do to save water?

d) What can we do to get more water?

e) If one person has some tickets left over, and another person doesn't, is it fair to trade?

f) If you are out of tickets now, do you wish you had saved some for later?

g) If you played this game again, would you do anything differently?

7. List with students things that they can do to make the water they have (at home and at school) go further. This list may include: turn water off while brushing teeth (saves about 2 gallons); take a short shower instead of a bath (saves at least 24 gallons); shut off dripping faucets (saves 1,000 gallons or more per year); turn the faucet off while soaping your hands, hair, or body; only get water in restaurants when you are going to drink it; etc.

EXTENSION:

1. Have older students write an essay entitled "The Day the Water Ran Out," and discuss that topic in class. Have younger students talk about what would happen if the water ran out.

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BACKGROUND:

On average, the human body requires about 2.5 quarts (2.4 liters) of water per day. But we use a lot more water than is needed internally. In the box below are some estimates of daily household water use for an American family.

Using the figure of 23 gallons (87 liters) per person per day, we use about 37 times more water than the body needs to survive. Some of this goes into activities like food preparation and hygiene, but how much water is wasted by one's lifestyle?

Compare the following domestic use per capita figures for an "average" family:

India:	6.75 gallons/day
Nigeria:	32.4 gallons/day
USA:	92 gallons/day

These figures demonstrate that lifestyle, availability of technology, and availability of water all affect the consumption rate of water.

Amount of Water Used Per Day Per Four-Person Household

Use	gallons	liters
toilet	25	95
shower	28	106
washing dishes	15	57
laundry	18	68
lavatory	3	11
basic needs	3	11
total	92	348

NAME____________________

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Tell the Town!

Communication tools can make a difference

SUMMARY: This activity should be done after previous groundwater activities. Several ways are provided for students to become informed and share information on groundwater.

OBJECTIVE: To explore ways that students can share with others what they know about groundwater.

VOCABULARY WORD: law
TIME REQUIRED: 10 minutes to several 45-minute periods
MATERIALS NEEDED:
Art materials
Blackboard or newsprint

PROCEDURE:

1. Brainstorm a list of ways that students can help protect groundwater at home. *(This might include water conservation techniques, preventing people from dumping used motor oil on the ground, not using household hazardous chemicals, reducing the amount of waste that they put in the landfill, etc.)* Write this list on the chalkboard or on a big piece of paper, and leave it up in a visible place in the classroom.

2. What school rules would students make to protect groundwater?

3. Discuss some of the laws that exist to protect and clean up groundwater. How do they compare to the rules that students created? Are the actual laws stronger or weaker than the students' rules? Why?

4. If others in the school do not know important facts about groundwater, discuss ways that students in your class can share what they have learned.

5. The following activities are optional, and can be chosen or modified depending on the grade level of your students.

a) Students can try to implement some of the rules to protect groundwater (or conserve water in general) that they created for the school.

b) Have students search for and report on groundwater topics they see on TV. Have them bring in newspaper clippings of groundwater topics and share them with the class. (Remember, this broad topic includes such items as hazardous waste, landfills, droughts, recycling, etc.)

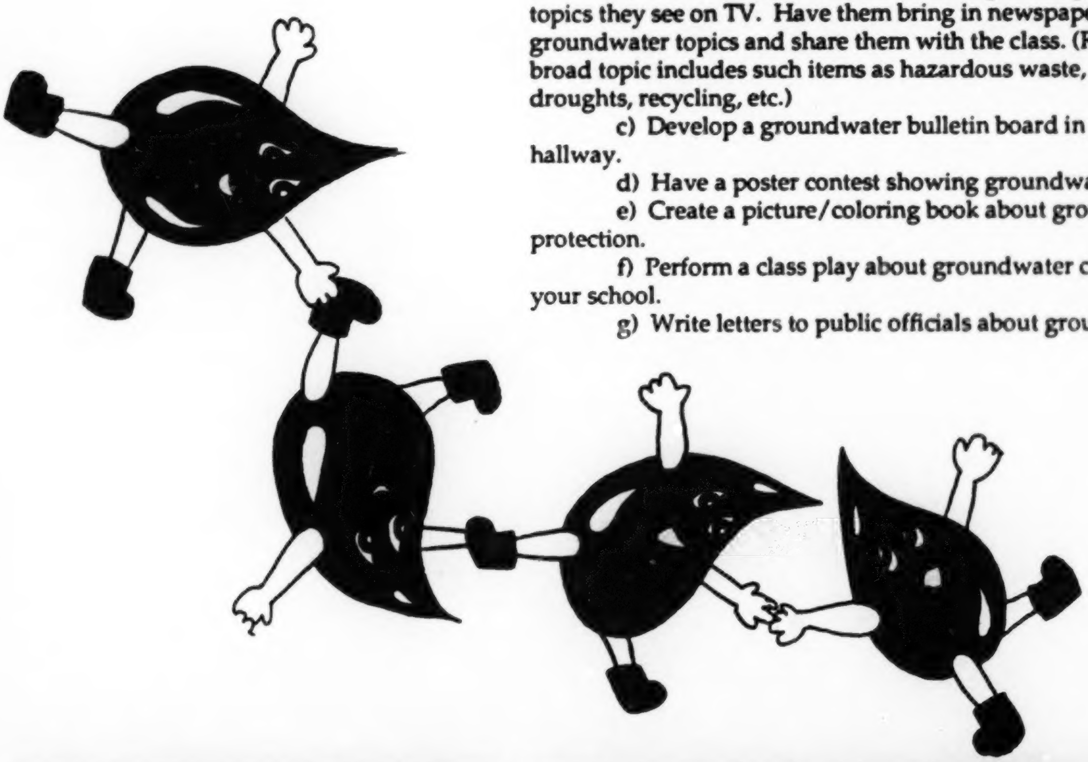
c) Develop a groundwater bulletin board in your school's hallway.

d) Have a poster contest showing groundwater protection.

e) Create a picture/coloring book about groundwater protection.

f) Perform a class play about groundwater characters for your school.

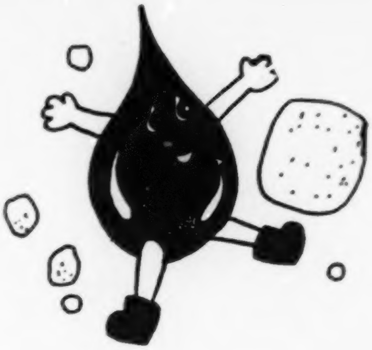
g) Write letters to public officials about groundwater.



BACKGROUND:

An important part of citizenship is realizing that it is up to all of us to prevent and solve the problems of our community, if at all possible. One key way of doing this is by staying informed and sharing what we know with others. When we know about potentially threatening situations, we can spread the word to others, organize, and prevent something that could be both dangerous and costly to the public and environment from happening.

Being informed about groundwater, how human activity can adversely affect it, and the importance of protecting it from depletion and contamination is no exception. By sharing the lessons we have learned with others, we stand a better chance of protecting groundwater, a valuable natural resource. Communication is the key.



ALTERNATIVE	a substance one can use instead of another substance with more harmful side effects.
AQUIFER	an underground layer of rock, sediment, or soil that is filled or saturated with water; such a formation is capable of storing and transmitting significant volumes of water to a well or spring.
AQUITARD	an underground bed or stratum of earth, gravel, or rock that will store and transmit water, but will not transmit water fast enough to supply individual wells.
AUGER	a tool used to bore a hole in the ground; may be used to get a soil sample which contains different layers of soil.
CIRCLE	a figure on which each point is the same distance from the center of the figure as every other point; also, the starting point of the circle will always be the end point as well.
CLAY	very fine-grained rock, sediment and soil particles (size less than 0.01 mm); it is usually made up of hydrous silicates, mainly of aluminum and magnesium, which have the ability to take up and lose water.
CLIMATE	the general weather conditions of a particular region.
CLOUD	a mass of suspended water droplets and/or ice crystals in the atmosphere.
COMPANY	a business that produces something like paper, power, or cars which other people buy. Some types of businesses or industries have a large impact on groundwater quality because of the chemicals they use or produce (either to sell or as by-products), and the methods they use in disposing of them.
COMPOST	when waste that can decompose is stored so that it will break down into material that can be used to enrich soil.
CONDENSATION	the process whereby a gas changes into a liquid. Water vapor in the air condenses to form water droplets.
CONSERVE	to use as little of a resource as possible. Many of us do not realize how much water we use; one estimate says that the average American uses 60 gallons of water each day just inside the home. There are many simple ways in which we can practice conserving water.
COPPER	a metal commonly found in groundwater that is not harmful to health in small amounts; often causes greenish-blue stains in sinks, tubs, and toilets. Another source of copper in water is the copper pipes used in the plumbing of many older homes.
CYCLE	a series of events that keep occurring in a set pattern, such as the water cycle.
DISPOSE	to throw away or get rid of something.
DISSOLVE	to cause a substance to go into solution. Many minerals, once in the soil, will be readily dissolved by water percolating through the soil from precipitation, irrigation, etc. These minerals often end up in the groundwater. A common example of this is salt used to melt ice and snow on roads.

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DROPLET	a small drop of liquid; in the water cycle, droplets are formed when water vapor condenses, leading to precipitation.
ENERGY	something that powers an activity. Sunlight provides the energy plants need to carry out photosynthesis; fossil fuels power many of our forms of transportaion. The way in which some forms of energy are used (e.g., the burning of fossil fuels,)results in air and water pollution.
EROSION	the carrying away of sediments by wind, moving water, or ice.
EVAPORATION	the process whereby water is changed from a liquid to a gaseous state (water vapor); this process is part of the water cycle.
FERTILIZER	a substance added to the soil to improve crop production; the nutrient elements most important to plant growth are nitrogen, phosphorus, and potassium. Many of the ingredients in fertilizers are carried to the groundwater below by the percolation of water.
FORMATION	the fundamental mappable body of rock that is distinct from adjacent bodies of rock. It is usually named for the original area in which it was studied, such as the Coldwater Shale. The structure of a body of rock, such as the amount of empty space between particles, helps determine whether or not water can move through the body.
FRESH WATER	water that does not have undesirable amounts of dissolved minerals in it. Since we are not able to consume salt water, our lives are dependent on our supplies of fresh water. Fresh water accounts for only about 3% of all the water on earth, the other 97% is salt water.
GAS	the form of a substance in which it can expand indefinitely; vapor.
GLACIER	a large mass of ice formed on land by the compacting and recrystallization of snow. Glaciers survive from year to year, and creep downslope or outward due to the stress of their own weight.
GLOBE	a spherical object used to represent the earth.
GRAVEL	a mixture of coarse particles such as pebbles (particle size is from 0.1 to 10 mm).
GRAVITY	the force which pulls all objects toward the earth.
GROUNDWATER	water below the water table in the zone of saturation. Groundwater fills all the spaces between the soil and sediment particles or the cracks and crevices in rocks. Groundwater supplies about half of the population of the United States with drinking water.
HAIL	transparent or layered (ice and snow) balls or irregular lumps of solid water; hail usually falls from cumuloform clouds that have formed into cumulonimbus clouds or thunderheads.
HAZARDOUS	A material causing special problems to people or the environment because it is caustic, explosive, infectious, toxic, or radioactive.

HAZARDOUS WASTE	waste that causes special problems (see Hazardous) to people or the environment. Our groundwater supplies are particularly susceptible to contamination from hazardous wastes that are dumped on or buried in the ground.
HOUSEHOLD CHEMICALS	chemicals that are commonly found around the house such as window cleaner, chemical drain uncloggers, or pesticides. Many of these chemicals are hazardous and should be disposed of properly. When in doubt about proper disposal, call your county public health department.
INFILTRATION	the entrance or flow of water into the soil, sediments, or rocks of the earth's surface; also called percolation.
IRON	a metal commonly found in groundwater which is not harmful to health; often causes orange-to-red stains in sinks, tubs, and toilets.
(SANITARY) LANDFILL	method of disposing of solid waste on land by keeping the waste at the smallest possible volume and covering it with a layer of earth; properly constructed sanitary landfills are lined with clay and plastic, and have leachate collection systems. An improperly constructed landfill is known as a "dump." When landfills have leaky liners they can easily be sources of groundwater contamination.
LAYERS	strata of different geological materials (such as clay, sandstone, shale, etc.) in the earth's crust that determine how groundwater can flow through that area. Some substances, like sand or gravel, allow water to pass through fairly quickly, while other materials, like shale or clay, will impede or prevent the flow of water.
LAW	a rule made by the government. Some of our laws are designed to prevent the contamination of our groundwater mainly through the regulation of waste disposal.
LEACHATE	undesirable material which is picked up and carried, either in suspended form or in solution, by the action of water moving through the contaminated soil and waste.
LINER	a layer of plastic, clay, or other synthetic materials placed under a landfill to prevent leachate from leaking out. Holes in the liner may lead to groundwater contamination.
LIQUID	readily flowing; fluid.
MOTOR OIL	a lubricant for engines, especially automobile engines. Motor oil needs to be changed periodically; when people change it they often dump it on the ground or down the storm sewer, which leads to the contamination of both our ground and surface water. Many people do not realize that used motor oil can be recycled.
NATURAL RESOURCES	the usable materials we get from the earth, such as timber, coal, minerals, fresh water, etc.
NON-TOXIC	not poisonous. Some substances, such as iron, are non-toxic, so they are not a threat to our groundwater.

OCEAN	a very large body of salt water.
OVERDRAFT	to use more than you have or can afford. Especially in arid regions such as the American Southwest, people are using water faster than it can be replenished.
PAVED	covered by a layer of cement or asphalt. Water tends to run off paved surfaces because it can not move through them; on road surfaces this run-off often contains contaminants such as oil from cars.
PEN PAL	someone you meet and become friends with, and the only contact is made through writing letters.
PERCOLATE	the downward flow or seepage of water through the pores or spaces of rock or soil.
PERMEABILITY	A measure of the interconnectedness of pore spaces within any earth material. It is usually measured by the rate at which a fluid of standard viscosity can move a given distance through a given period of time.
PLACE	a location or site.
POLAR ICE CAPS	the vast amounts of frozen water that exist at the north and south poles. Approximately 2/3 of the world's fresh water is locked up in these ice caps.
POLLUTANT	a harmful substance deposited in the air or water or on land, leading to a state of impurity or unhealthiness.
POLLUTE	to put harmful substances (pollutants) into the environment.
POROSITY	the percentage of the total volume of rock or earth material that is void space or pore space.
PRECIPITATION	water falling toward the earth in the form of rain, drizzle, hail, sleet or snow.
RAIN	precipitation that consists mainly of water droplets.
RECHARGE AREA	an area where water flows into the earth (infiltrates) and resupplies an aquifer.
RECYCLE	the processing of material to be used again in its original form or in a similar form.
REGION	a large area with environmental or socioeconomic characteristics that make it distinct from adjoining areas.
REUSE	to use an object or material again after its original use is over instead of discarding it. For example, plastic milk containers can be cleaned out and used to store another substance (perhaps used motor oil awaiting recycling) once the milk has been used up.
ROCK	a relatively hard, naturally-occurring material made up of minerals.

RUN-OFF	water that travels over the surface of the earth, moving downward due to the law of gravity. Run-off, which includes stream flow and overland flow, is one way in which water that falls as precipitation returns to the ocean. When run-off moves across material that is permeable, some of the water will move down into the ground. If this water moves all the way down to an aquifer, this is recharge.
SALT	any of a class of generally ionic compounds that may be formed by reaction of an acid and a base. Salts dissolve in water. Commonly found in groundwater are iron and copper. Road salts can contaminate groundwater by dissolving in precipitation that then infiltrates the soil.
SALT WATER	water that contains large amounts of dissolved minerals, particularly sodium and chloride. About 97% of the earth's water is salt water that humans cannot drink.
SAND	a fine-grained mineral material which is coarser than silt and clay and finer than gravel (particle size from 0.06 to 2.00 mm); most sands are predominantly made up of quartz.
SATURATED	the condition of being filled to capacity. When the atmosphere contains all the water vapor it can hold, it is filled to saturation, and the relative humidity is 100%. When rocks, sediment, or soil contain all the water they can hold, they are saturated with water.
SEDIMENTS	particles of material produced by weathering and erosion of rocks. Sediments may remain on the earth's surface as soil or sediment, or may be transported and deposited in other locations by wind, streams, and other erosional agents.
SEWER	a channel or pipe which carries sewage or stormwater.
SLEET	precipitation that consists of clear pellets of ice; sleet forms when raindrops pass through a layer of cold air and freeze.
SNOW	precipitation that consists of frozen flakes formed when water vapor accumulates on ice crystals, going directly to the ice phase.
SOIL	sediment on or near the erth's surface that is formed by the chemical and physical weathering of rocks as well as the decay of living matter. Soil is a sediment capable of supporting the growth of land plants. Substances which are put in the soil, such as fertilizers, may end up in the underlying groundwater.
SOLID WASTE	the waste material that generally gets disposed of in a landfill. This waste may include hazardous materials such as old batteries and discarded household chemicals.
SOURCE	where something comes from. The source of a well or spring is an aquifer; we might also speak in terms of the source of some water pollution.
SPOUT	a small tube or pipe which water flows out of.
SPRING	groundwater seeping or flowing out of the earth's surface; springs occur where the water table intersects the surface.

SUPPLY	the part of a resource that is stored away. Our supply of fresh water is all the fresh water we have not used yet.
SURFACE WATER	all the water on the surface of the earth including rivers, lakes, ponds, etc. Approximately half the population of the United States relies on surface water as the source of their fresh water.
TOXIC	poisonous. Many common household substances, such as cleansers, antifreeze, and pesticides, are toxic and can end up contaminating groundwater if not disposed of properly.
TRANSPIRATION	the process by which living plants give off water vapor into the atmosphere.
USABLE	able to serve a purpose. Usable water is water we can use for some purpose. Some water becomes so polluted that there are very few purposes for which it can be used safely.
WATER CYCLE	the continuous circulation of water in systems throughout the planet, involving condensation, precipitation, runoff, percolation, evaporation and transpiration.
WATER TABLE	the upper surface of the zone of saturation.
WATERFALL	a place where the course of flowing water makes a steep dive virtually straight down.
WAVE	a ridge or swell moving across the surface of a body of water.
WELL	a deep hole dug in the earth to get at a natural deposit such as water or oil. Abandoned wells are sometimes used as waste disposal sites; unfortunately they may lead directly to the underlying groundwater.
ZONE OF AERATION	area between the ground surface and the water table.
ZONE OF SATURATION	area underground in which every available space is filled with water.

MICHIGAN SOIL CONSERVATION OFFICES

Write to "Soil Conservation District" at each of these addresses:

AREA 5—FLINT

Hillsdale County Soil Survey Office c/o Friend of the Court 61 McCollum Hillsdale, MI 49242	(517)437-7530 Hillsdale County
Faulhaber Building Adrian, MI 49221-2066	(517)265-5887 Lenawee County
6101 Jackson Rd. Ann Arbor, MI 48103-9598	(313)761-6722 Washtenaw and Wayne Counties
46 Westland Dr. Route #4 Bad Axe, MI 48413-9804	(517) 269-9540 Huron County
852 South Hooper Caro, MI 48723-1754	(517)673-8174 Tuscola County
1525 North Elms Rd. Flint, MI 48532	(313)230-8781 Genesee County
3251 Beck Rd. Hillsdale, MI 49242-9406	(517)439-1497 Hillsdale County
3477 E. Grand River Howell, MI 48843-8552	(517)548-1553 Livingston County
211 W. Ganson St. Jackson, MI 49201-1216	(517)748-2800 Jackson County
237 Davis Lake Rd. Lapeer, MI 48446-1493	(313)664-3941 Lapeer County
312 North St. P.O. Box 236 Mason, MI 48854-0236	(517)676-5543 Ingham County

1137 S. Telegraph Monroe, MI 48161-4005	(313)241-7755 Monroe County
1767 South M-52 Owosso, MI 48867-9201	(517)723-8264 Shiawassee County
8326 Highland Rd. Pontiac, MI 48054-1113	(313)666-2232 Oakland County
2830 Wadhams Rd. Port Huron, MI 48060-2353	(313)9843866 St. Clair County
The Plaza Building, Suite D-303 67533 Main St. Richmond, MI 48062-9221	(313)727-2306 Macomb County
75 Dawson St. Sandusky, MI 48471-1062	(313)648-2116 Sanilac County

AREA 1—MARQUETTE

Iron County Soil Survey Office 1388 U.S. Highway 2 Crystal Falls, MI 49855-4094	(906)875-3038 Iron County
U.S. Highway 2 P.O. Box 396 Naubinway, MI 49762-0396	(906)477-6059 Mackinac County
Marrquette County Service Center 184 U.S. 41 East Negaunee, MI 49866	(906)475-4603 Marquette County
Courthouse Annex Crystal Falls, MI 49920	(906)875-3765 Iron County
2805 North Lincoln Rd. P.O. Box 680 Escanaba, MI 49829-0680	(906)786-8212 Delta County
300 Dunstan St. Hancock, MI 49930-2117	(906)482-0360 Baraga,Houghton, Keweenaw Counties

102 North Hooper St. Kingsford, MI 49801-8548	(906)774-1550 Dickinson County
Courthouse, Room 221 300 Walnut St. Manistique, MI 49854-1414	(906)341-5304 Schoolcraft, Luce,western Mackinac Counties
104 Coles Dr. Marquette, MI 49855-4010	(906)226-9460 Marquette and Alger Counties
900 River St. Ontonagon, MI 49953-1622	(906)884-2141 Gogebic and Ontonagan Counties
2769 Ashmun St. M-129 Sault Ste. Marie, MI 49783-3730	(906)632-7051 Chippewa and eastern Mackinac Counties
Stephenson Hotel Building Stephenson, MI 49887-0484	(906)753-2513 Menominee County

AREA 2—TRAVERSE CITY

102 East Fifth St. Scottville, MI 49454-1214	(616)757-3030 Mason County
1084 Wilcox P.O. Box 241 White Cloud, MI 49349-0241	(616)689-7291 Newaygo County
Oceana County Soil Survey Office County Building 100 State St. P.O. Box 87 Hart, MI 49420-0087	(616)873-7139 Oceana County
6433 8 Mile Rd. Bear Lake, MI 49614-9712	(616)889-9666 Manistee and Benzie Counties
Depot St., Complex 2 P.O.Box 312 Bellaire, MI 49615-0312	(616)533-8709 Antrim and Kalkaska Counties

18715 Chippewa Lake Rd. Rt. 4, Box 18A Big Rapids, MI 49307-0001	(616)796-2650 Mecosta County
City Hall, 319 North Lake St. Boyne City, MI 49712-1101	(616) 582-7341 Charlevoix and Emmet Counties
3060 West 13th St. Cadillac, MI 49601-9658	(616)775-7422 Wexford County
940 West Rex St. Fremont, MI 49412-1037	(616)924-2060 Newaygo County
6180 West Sanborn Rd., Room 126 Lake City, MI 49651-9330	(616)839-7193 Missaukee County
Old M-204, Buenk Building, Box 205 Lake Leelanau, MI 49653-0205	(616)256-9783 Leelanau County
770 South Patterson Rd. Box 219, RR# 2 Reed City, MI 49677-9634	(616)832-5438 Osceola annd eastern Lake Counties
862 West U.S.-10 Scottville, MI 49454-9601	(616)757-3708 Mason and western Lake Counties
20 South Oceana Dr. Shelby, MI 49455-9634	(616)861-4967 Oceana County
1222 Rennie St Traverse City, MI 49684-4454	(616)941-0960 Grand Traverse County

AREA 3—GRAYLING

Alcona County Soil Survey Office Courthouse Annex, 311 Lake St. P.O. Box 291 Harrisville, MI 48740	(517)724-6746 Alcona County
265 S. Graham Rd. Saginaw, MI 48603-9423	(517)781-0675 Saginaw County
815 Miller St. Alpena, MI 49707-1825	(517)356-6038 Alpena and Montmorency Counties

3949 South 3 Mile Bay City, MI 48706-9215	(517)684-1040 Bay County
Room 112, Courthouse P.O. Box 70 Cheboygan, MI 49721-0070	(616)627-2565 Cheboygan County
Room 119, Federal Building East Tawas, MI 48730	(517)362-2591 Iosco County
202 Livingston Building B, Center Apt. Gaylord, MI 49735-9387	(517)732-6526 Otsego, Crawford, and Roscommon Counties
731 North M-18 Gladwin, MI 48624-1257	(517)426-9621 Gladwin County
Room 141, Courthouse Basement 225 W. Main St. Harrison, MI 48625	(517)539-6401 Clare County
311 Lake St., P.O.Box 291 Harrisville, MI 48740	(517)724-5272 Alcona County
1326 East Center, P.O.Box 166 Ithaca, MI 48847-0166	(517)875-3401 Gratiot County
1864 East Isabella Rd., Route #2 Midland, MI 48640-9812	(517)772-9152 Midland County
200 North Main, Isabella County Building Mt. Pleasant, MI 48858-2321	(517)772-9152 Isabella County
240 W. Erie St. Rogers City, MI 49779-1629	(517)734-4000 Presque Isle County
265 South Graham Rd. Saginaw, MI 48603-9423	(517)781-4070 Saginaw County
120 North Grove St., Courthouse Standish, MI 48658	(517)846-4566 Arenac County
240 West Wright West Branch, MI 48661-1444	(517)345-5473 Ogemaw and Oscoda Counties

AREA 4—GRAND RAPIDS

1127 E. State St. Cassopolis, MI 49031-9339	(616)445-8643 Cass County
685 East Main Centreville, MI 49032-9613	(616)467-6088 St. Joseph County
200 N. Bostwick Charlotte, MI 48813-1410	(517)543-1539 Eaton County
1110 W. Chicago Rd. Coldwater, MI 49036-9307	(517)278-8008 Branch County
16731 Ferris St. Grand Haven, MI 49417-9601	(616)842-5869 Ottawa County
3260 Eagle Park Dr., Suite 101-B Grand Rapids, MI 49505-4569	(616)940-1708 Kent County
535 West Woodlawn Hastings, MI 49058-1095	(616)948-8038 Barry County
1969 S. State Rd. Ionia, MI 48846-2131	(616)527-2620 Ionia County
1911 W. Center Ave. Kalamazoo, MI 49002-5333	(616)327-0696 Kalamazoo County
18625 Centennial Rd. Marshall, MI 49068-9360	(616)781-4264 Calhoun County
940 Van Eyck St. Muskegon, MI 49442-3199	(616)788-3492 Muskegon County
219 Paw Paw St. Paw Paw, MI 49079	(616)657-4220 Part of Van Buren County
306 Elm St. St. Johns, MI 48879-2347	(517)224-4318 Clinton County
3830 M-139 St. Joseph, MI 49085-9605	(616)429-4231 Berrien County
806 N. State Stanton, MI 48888-9799	(517)831-4606 Montcalm County

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